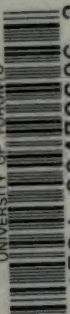


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CATALOGUE
OF THE
MADREPORARIAN CORALS
IN THE
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(NATURAL HISTORY).

VOLUME VI.
THE FAMILY PORITIDÆ.
II.—THE GENUS PORITES.

PART II.—PORITES OF THE ATLANTIC AND
WEST INDIES, WITH THE EUROPEAN FOSSIL FORMS.

THE GENUS GONIOPORA,
A SUPPLEMENT TO VOL. IV.

BY
HENRY M. BERNARD, M.A.

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P R E F A C E.

THE present volume completes the description of the genus *Porites*, and contains also a descriptive list of *Gonioporæ*, supplementary to that given in Vol. IV.

The Museum collection is not extensive, and from the Atlantic basin there are only about 50 forms of *Porites*. A number, however, not in the collection, have been described by other naturalists; in order to study some of these, and especially the types of Lamarck, the Author paid a visit to Paris, where he received the most courteous assistance from the officers in charge, and especially from Dr. Gravier; later on, that gentleman most kindly superintended the preparation of a series of photographs of some of the more important types in the Paris Museum for this volume.

The volume has been edited by Mr. F. JEFFREY BELL. He has in this volume left the Author's observations and modes of stating them much more in the Author's original words than in previous volumes, feeling that, as this is the last volume which will be published with the method of nomenclature here adopted, it is only right that the Author should express himself in his own way.

The genus appears to be comparatively recent, and this may be the explanation of the paucity of fossil types. Mr. BULLEN NEWTON, of the Geological Department, has afforded Mr. BERNARD all the advice and assistance he required.

E. RAY LANKESTER.

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October 11th, 1906.

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CATALOGUE
OF
MADREPORARIA.

VOLUME VI.

The Genus PORITES.

Part II.

PORITES OF THE ATLANTIC AND
WEST INDIAN AREA.

I. INTRODUCTORY.

VOLUME V. contains a list with descriptions, analytical tables, and illustrations of the forms of this genus—the most ubiquitous of all reef-forming corals—which are known to belong to the Indo-Pacific region. Large as the list is, we may legitimately conclude that it represents but a small selection of the forms now inhabiting that vast area, while the few mentions of fossils supply little more than a hint as to the previous existence of many generations ancestral to those now living round its innumerable shores or building up its reefs.

This Volume is a continuation of our account of the genus, but contains the forms which are so far known living in the Atlantic Oceans, North and South, in the West Indian Islands and Gulf of Mexico on the west, and fossil in the Paris and Mediterranean Basins on the east.

The division of the genus into the Indo-Pacific and the Atlantic and West Indian forms each treated in a separate volume is morphologically justifiable, because the latter prove on examination to have characters of their own which constitute them a group apart. This point is especially interesting. It is in keeping with the conclusion at which our work has brought us: that while free-living organisms with highly developed powers of locomotion, such as fish or birds, may spread freely over the surface of the globe, and thus be largely independent of

locality, this is not the case with sessile forms as highly developed as the Corals. Whatever the "species" of corals may be, we know nothing about them, and can know nothing about them until we study them by means of experimental cultivation. We only know the local forms. Hence local forms are the only available units with which we can do solid work. We have to study them with a view to arranging them into larger groups extending over larger areas. We are not, therefore, surprised to find that the forms inhabiting the Atlantic area have a character of their own distinguishing them from those inhabiting the Indo-Pacific. We might have assumed it, but as a matter of fact, its discovery was solely due to observation and analysis. What these distinguishing features of the Atlantic forms are will be described below in the morphological section, p. 12.

It now seems probable that the forms of the Indo-Pacific region will ultimately have to be divided into smaller groups corresponding to definite areas: for instance, that the Red Sea forms will be found to have characters peculiarly their own. A dim perception of this was pointed out by the author—but, as he now thinks, quite misunderstood—with regard to the genus *Turbinaria* (see Vol. II., 1896, p. 18, last paragraph.) If this can be established generally, a great reform in the classification of the Corals cannot be long delayed. All purely imaginary groups such as species or morphological "forms" of indefinite distribution will be abandoned as units, and the Corals will have to be treated as we treat the races of men—as *factors in the areas which they inhabit*, and upon the conditions of which they largely depend for their peculiarities.

In connection with this fact that the forms to be dealt with in this Volume show structural peculiarities, distinguishing them from the Indo-Pacific forms, we may point out that the Atlantic area is now for all practical purposes, that is so far as *Porites* is concerned, quite separated from the Indo-Pacific, and has been thus separated for an indefinite period. It is true that *Porites* creep down the east coast of Africa apparently in isolated specimens beyond the limit of coral reefs. For instance, one such is found at the Cape of Good Hope (see p. 25), but as we pass into the Atlantic round the Cape point the temperature of the water immediately falls, apparently rendering the existence of *Porites* impossible. Certain it is that the first isolated specimens known to occur on the Eastern shore of the Atlantic are found in the Gaboon Estuary, nearly 2500 miles to the north of the Cape (see p. 25). If on the eastern side of the Atlantic, the two *Porites* areas on the sides of the Cape of Good Hope, are separated by conditions of temperature, the same is still more obviously the case at Cape Horn. The most southerly *Porites* so far known on the Pacific shores of South America occurs in the Bay of Panama, on the Atlantic side on the Abrolhos reefs, south of Porto Seguro, nearly 3500 miles north of Cape Horn. Further research is certain to reveal Pacific forms much further south than the Bay of Panama, but there is no chance whatever with the known temperature conditions at the Straits of Magellan that the Pacific and Atlantic *Porites* faunas meet, or have met, within recent geological periods.

No connection between the Pacific and Atlantic oceans seems to have existed across the Isthmus of Panama since the early Miocene or possibly since the Oligocene.* But on the

* Cf. Professor Gregory, Quart. Journ. Geol. Soc. li. (1895) p. 308.

eastern side of the Atlantic Ocean, a chain of fossiliferous areas—some of them, e.g. the Paris Basin, the Italian Miocene, the Egyptian Desert and Persia, very rich in Poritids—connects the Atlantic with the East. But there seems to be no certainty as to whether these at any time formed actual co-existing links. This matter of co-existence need not be important: it is enough that Tertiary seas have at one time or another opened into one another, making it possible for Poritids to spread from West to East and East to West. Tertiary deposits in Asia, indicate that there may have been water connection between the Mediterranean and the Indian Ocean by way of Persia and the Persian Gulf, and between the Mediterranean and the Pacific across Asia; while, on the other hand, there is evidence for the belief that the Mediterranean area was at one time in zoological connection across the Atlantic with the West Indies. A study of the Tertiary strata for the purpose of ascertaining the conditions of their Poritid faunas is a desideratum. The earliest appearance of the genus *Goniopora* occurs in the lower Cretaceous of the Crimea. It seems to have reached its maximum in the middle Tertiaries. It is possible that *Porites*, as a derivative of *Goniopora*, is attaining its maximum in modern seas.

This suggestion is based upon the reviews of the family contained in Vols. IV., V., VI. of this Catalogue. It will there be found that the great bulk of the fossil Poritids which have been found in the Tertiary strata, of which the records have been referred to by the writer, nearly seventy belong to the older genus *Goniopora*, while less than ten belong to the genus *Porites*.

Unless further research reverses this proportion, its significance for the evolutionary history of *Porites*, as a derivative of *Goniopora*, is of weight. In this connection, we may mention that the discovery of fossil *Goniopora* in Jamaica (though no living form is known to occur in the West Indies to-day) is in harmony with the view that the genus *Goniopora* has had its day, and has been giving place to *Porites*. [See Vol. IV., p. 27, and Vol. V., p. 24, for the morphological derivation of the *Porites* from *Goniopora* by the suppression of the tertiary septa, not as a gradual process of abortion, but by the early ripening and fixing of immature forms, that is, of early stages which have not yet developed their tertiary septa.]

II. HISTORICAL.

A brief sketch of the family Poritidæ was given in Vol. IV. p. 4, and of the genus *Porites* in Vol. V. p. 3. We can, therefore, here confine our attention entirely to a sketch of the work done on the Atlantic and West Indian representatives of the genus. The partial and separate treatment is quite justifiable not only on the grounds of morphology—inasmuch as we shall show in the next section, p. 12, that the forms of this region are a group apart—but also because the story is complete in itself, nowhere overlaps, and is more than ordinarily instructive. It supplies us with an ideal illustration of the futility of trying to build up any solid knowledge of the closer inter-relationships of the forms of life by the help of imaginary units, whether we call those units “species” or “forms.” For both of them are imaginary,

inasmuch as they are assumptions that every specimen which comes into our hands must represent a number of similar forms *indefinitely* distributed over more or less extensive areas. The only difference between the species and the form is that the former word connotes close genetic affinity of all such similar individuals, while the latter simply says that they resemble one another, their resemblance being either genetic and accidental or convergent. Both these assumptions, although here we are only concerned with the "species," are, as the story will explain, not entirely, but in some important elements, imaginary, and it is just the imaginary elements which have made them as useless for work on the Corals as it will be shown that they have been.

I repeat that both of these units are imaginary. The "species" is imaginary, inasmuch as, though we are quite justified in postulating a genetic group composed of the closest genetically related forms of every specimen we come across, it fades away in all directions, altering its shape as it goes, and is thus without any definiteness, either of form or distribution. The "form" is imaginary, inasmuch as we do not know of its existence at all. We have far too little insight into the essential form-features of such organisms as Corals to say that any two are alike except most superficially and to the eye of the individual worker, whereas the next student may point out a score of important differences. In order to make any solid progress, we must first of all find a unit of work, the essential of the unit being that it is an ascertainable and definable fact.

All who have been following the progress of this Catalogue will have noticed that the futility of the imaginary species was early felt, and was followed by an attempt to discover a new definable unit. A geographical form was suggested as somewhat of a leap in the dark, inasmuch as it was difficult to say what it represented. To all appearance it represented nothing more than the individual specimen, so that classifying by such a unit was apparently nothing more than the description of every individual specimen to begin with, in the hopes that a second step might lead us to some possible grouping in the future.

The history of the West Indian *Porites* is, then, especially instructive, as it shows, with singular compactness and lucidity, first of all the disastrous results of working with an imaginary unit, and in the second place that Nature herself offers us an ideal unit, which is not a mere individual, but a local form, that is, a form which seems to be fairly clearly definable for each locality; indeed, it appears that there may be more than one in any single locality growing side by side *without intergrading*. This story, then, supplies us at last with a solid content for the geographical name. It is true, of course, that the individual specimen had, strictly speaking, a solid content, but it was meagre in the extreme, and artificial—a product of the Museum cupboard—whereas the new content is a real fact of Nature taken from her own workshop, and thus supplying us with a small clue to the way in which she works. The discovery of this is the aim not only of all systematic zoology, but of all science.

I am, of course, aware that, for all we know, these local forms may have hazy and indefinite distributions; still we now have at least two solid facts of knowledge about them, namely (1) that they have such-and-such characters, and (2) that they are, however indefinitely,

certainly associated with such-and-such localities. We shall further find the following story interesting, because it reveals the difficulty of designating the units by their characters, thus leaving the name of the locality as the simplest and most obvious factor to be used for the purposes of reference.

The story of the West Indian *Porites* may be said to begin with three forms which Lamarck briefly specified in his "Animaux sans Vertebres," ii. (1816) p. 263, under the division, "Les Animaux Lamellifères." These forms were *Porites clavaria*, *Porites furcata*, and *Porites astrœoides*. The originals are fortunately still preserved in the Paris Museum. With regard to them, we have to note two facts of importance for the understanding of the following history: (a) the exact localities from which they came are unknown *; (b) the names *clavaria* and *furcata* bore no special comparative significance. They did not imply that one was *more* club-shaped than the other, which was more openly forked. They were mere names suggested by the forms independently, and totally without reference to one another. A moment's glance at the figures makes this apparent. (See Pl. XIII. fig. 1; Pl. XII. fig. 1).

It is clear, then, that not much was known about these specimens except their names, for, as we shall see later on, the only published figure of one of them—prior to those given in this volume—has been almost entirely ignored. And yet in spite of (perhaps because of) this ignorance, we have the "*species*," which these three were supposed to represent, assuming colossal proportions in the minds of naturalists, spoken of as if familiar to every one, as if inhabiting the whole of the West Indies, so that every worker expected and seems to have wished to see one of them in every fresh form discovered. The following story is practically that of the triumph of this wish. At first, it was baffled by the facts, but it eventually gained a victory which, needless to say, was not only absolutely without any value whatever to science, but has practically to be ignored before we can begin again with the facts.

I do not mean by this that all the work done has been useless: far from it. The collection of facts, some valuable contribution to which has been made by every one of the writers whose works we shall quote, has permanent value, but *only so far as we can disentangle them as facts from the network spun over them of imaginary specific relationships*, which the mind now conjures up in association with every striking specimen discovered. No one can deny, of course, that every specimen necessarily connotes a group of genetically related forms. But the whole problem, with all the initial mistakes as to its method of solution, has turned simply upon the legitimacy of our conceptions as to the nature and extent of this said group of genetically related forms. The result of this story will be, I hope, to give at last some not only definable but demonstrable meaning to the group; not till this has been done can it become a workable unit.

The first work to deal exclusively with West Indian corals is that of Lesueur † in 1820.

* "*Astrœoides*" was said to come from "L'Océan Américain," *clavaria* from "Les Mers d'Amérique et de l'Inde," while *furcata* was from some unknown region. Throughout this volume I have assumed that Lamarck's "mers d'Amérique" means the West Indies; for with these islands France appears to have been in frequent communication. Many of them are still French.

† Mem. du Muséum, vi. p. 271.

The following islands were visited: Barbadoes, St. Vincent, Martinique, Guadalupe, St. Bartholomew, St. Eustatius, St. Christopher, and St. Cross. The corals were referred to as "*Les animaux lamellifères*," Lesueur's main object being to study the animals themselves, Lamarck having merely described their dried coralla.

Lesueur, according to the habit of thought at the time, doubtless expected to find some one or other of the three "species" of Lamarck. At Guadalupe he found a thin, encrusting form, creeping over the irregularities of the substratum, and thus with an irregular surface of its own. Its beautiful yellow polyps made it appear like a field covered with little flowers. This, he thought, was a specimen of Lamarck's *P. astræoides*. Lamarck himself appears to have referred to more than one specimen, and he said that his species formed "*des larges plaques encroûtantes*." There are some large flat cakes in the Paris Museum called *P. astræoides*, and some are doubtless those seen by Lamarck. Milne-Edwards and Haime* first suppressed the species and merged it with the old massive *P. conglomerata* of Esper, of the eastern region, and further, their description seems to imply that the forms were all massive. There was thus probably no real resemblance between Lesueur's *astræoides* and Lamarck's (see below, p. 15 on the distinctions between the encrusting forms). Nevertheless, the imaginary "species" received it, and but that Lesueur figured and described it, his observation would have been as good as lost. He was even less fortunate in discovering representatives of either of the two branching "species." Branching forms he found, but had to regard them as new species, such as *divaricata*, *flabelliformis*, *recta*. This last, which was from St. Bartholomew Island, apparently grew in sand, and shot up straight and smooth so as to raise the living colony, always confined strictly to the top, as fast as possible above that, to the soft bodies of the polyps' dangerous element; only high up above the sand did the coral attempt to branch. One other form found at Nevis Island growing in this same medium, and showing the same general characters, instead of branching, formed a cluster of round knobs at the tip. This last club-like corallum proved a snare by suggesting a name, for he called it "*Porites clavaria*," or the club-shaped *Porites*, and then added "Lamarck," as if it must be the same species as Lamarck's coral. Two more widely different forms could hardly be found!

Dana, in his "Zoophytes" (1846) described two new forms from Barbados; one he called "*flexuosa*," and the other he "identified" with Lamarck's *furcata* (Milne-Edwards and Haime's figure of the original type of "*furcata*" not having been published at the time Dana wrote).

The first work on *Porites* by these last-named classical French naturalists* was in 1851. It did not add much to our knowledge of the West Indian forms themselves. The effect even of the excellent figures which they gave of some fragments of Lamarck's *Porites furcata* seems to have been neutralised by the title of the Plate, "La Structure de la Porite." This title appears to have diverted attention from it as the type of "*furcata*." Had it borne its true title, the short, stout, round-topped stems shown as closely packed and fusing together, might have saved authors from unanimously assuming that *furcata* could be distinguished from

* Monographie des Poritids, Ann. Sci. Nat., xvi. (1851) p. 20.

clavaria by being more openly forked, and that *clavaria* had more club-shaped branches. Further, the figures have had a bewildering effect, for they have been supposed to represent the *general* structure of *Porites*, whereas the specimen figured is an extreme West Indian form, and it would be difficult to find another like it, certainly nowhere in the Indo-Pacific area. Only a set of diagrams such as we attempted in Vol. V. p. 14,* can convey to us some distant idea of the structure of *Porites*. Therefore the French figure, excellent as it may be as the type of *furcata*, is calculated to damp the ardour of every investigator at the very outset of his studies on *Porites*. I well remember that it was a standing enigma to myself for years, that is, until I discovered its place in the system.

Milne-Edwards and Haime's arbitrary treatment of Lamarck's *astræoides* has already been referred to, and was moreover described, as far as it could be unravelled, in Vol. V. p. 244.

The next work to be noted is that on the Corals of the Antilles (1860), by Duchassaing and Michelotti. It referred chiefly to forms collected at the Islands St. Thomas and Guadeloupe, although other localities are occasionally mentioned. In this work the *Porites* received but scant attention, the genus being dismissed in little over a page.

In addition to "les espèces connues" (!), that is, *clavaria* and *furcata* Lamarck, *flexuosa* Dana, *divaricata* Lesueur, they found five † which they thought to be new.

In 1864, the same authors published a supplement to their earlier work, and in this the *Porites* are more fully treated, and the classification of the genus fundamentally revised. Further examination had showed them new and striking differences, so that even the genus was split into three subgenera—*Porites* for the branching forms; *Neoporites* for encrusting forms, which were massive and tended to have a knob-like columella on what was often a solid basal floor; *Cosmoporites* for encrusting forms which are thin, creeping, and, for the most part, have a columellar tangle ("*columella laxa*"). The more branching or approximately branching forms are rescued from "les espèces connues," and given names of their own,‡ while one is identified as of the same species as Lesueur's *flabelliformis*.

It is important to note that every part of this work of Duchassaing and Michelotti is useful except those in which the authors identified "known species." The vicious custom was (and, alas! is) in vogue of calling a specimen by some old name, and giving neither figure nor description. The specimen which Lesueur thought was specifically identical with Lamarck's *clavaria*, he figured and described; we can all see that it was not *clavaria*, and no harm is done. But not so with these authors, and we are left almost entirely to conjecture as to the characters of the specimen which they called *clavaria*. The probability that it was not Lamarck's would have been very great had we not means of ascertaining this fact for certain, in that the authors arranged their forms into morphological divisions, and the supposed *clavarias* were placed

* Reproduced below, p. 139.

† That is, four encrusting forms, which were called *superficialis* (see p. 59), *incerta* (see p. 60), *guadalupensis* (see p. 45), and *agaricus* (see p. 105), while the only branching form was called *solanderi* (see p. 57). The rest of their collection was apparently distributed among the "known species."

‡ *Valida* (see p. 56), *plumieri* (see p. 58), and *macrocephala* (see p. 89).

under a heading "*B. septis pallulisque hirtis*," whereas, according to my Paris notes, these elements are quite smooth in Lamarck's original coral.

Up to this date, then, we find a struggle between the two tendencies; on the one hand, a kind of instinct to believe that every form discovered must belong to one or other of "les espèces connues," although all that was really known was little more than a few book names*; and on the other, the conviction forced home by actual observation and comparison that the differences were profound, and necessitated separate descriptions and names. Unfortunately, from this time onwards, it was the former tendency which carried the day.

In 1871, Pourtales studied the Florida reefs, a locality quite distinct from any of the localities we have yet named, and from which, so far as we know, no *Porites* had been recorded, or if it had been, it had not found its way into the larger treatises here referred to. Both encrusting and branching forms were found in great abundance. Without a word of comment, the former were assumed to be of the same species as the one Lamarck called *astræoides*, while the latter were divided between the supposed species *clavaria* and *furcata*. This process is perfectly natural according to the belief that coral "species" have wide indefinite distributions, and that, given any single specimen of coral, we may assume the existence of more or less extensively distributed "species," as we certainly could do if the Corals were endowed with the same powers of locomotion as is possessed by bird and fish. But we are beginning now to discover that this can no longer be assumed of the Corals. They are, so far as we know, local forms. Consequently, we begin to realise that we shall never recover Lamarck's forms *clavaria* and *furcata* until we discover the localities whence they were originally brought.

It is, of course, *possible* that they may have come from the Florida reefs, but it is far more probable that they came from some West Indian island with which France was at that time apparently in more frequent communication than with any other parts of the American seas. What is certain is that the attempt to force all branching *Porites* into one of two purely imaginary species "*clavaria*" and "*furcata*" began from this date. The wish referred to above seems to have begun to assert itself.

In the year 1880, the same writer† worked over the corals brought from the Florida reefs by Agassiz, and wrote the explanation of the Plates. Three different branching forms are illustrated, different not only in form of growth, but, if anything, even more strikingly different in the calicles. One is called *clavaria*, and the other two *furcata*. *All three of them are very different from Lamarck's originals.*

One almost instinctively asks what can be the difference between *clavaria* and *furcata* if ordinary differences are so completely ignored. It must be something very profound! It is, therefore, somewhat startling to find that it is nothing more than that *clavaria* is supposed to be more club-shaped and *furcata* more openly forked. We are, consequently, not surprised to

* And perhaps Milne-Edwards' beautiful, but generally neglected figures of *P. furcata*, see above, p. 6.

† Mem. Mus. Comp. Zool. pl. xii. figs. 4, 7; pl. xvi.

come across sentences expressive of the difficulty of always being able to decide as to which of the two any specimen should belong, but we are surprised that these great phantom species should have still been holding their own and imposing so completely upon the human mind. And yet, on the other hand, can it be wondered at? Surely not, when we remember how one naturalist after another has been hopelessly bewildered by the calicles of this genus. To this supreme difficulty the confusion must largely be attributed. There was nothing apparently to lay hold of in these imaginary species—nothing but the names, which referred solely to growth-form. Little or nothing was known about the value of the growth-form. While on the one hand, to ignore the calicles was impossible, on the other hand, to study them was only to be altogether bewildered, and disheartened with the whole subject. It could only have been some such bewilderment which prevented the next writer, Dr. Rathbun, from realising how valuable was his chief observation.

The next, and in some respects the most important work on the *Porites* of these American waters is Dr. Rathbun's Catalogue of the Specimens in the U.S. National Museum.* It is important (1) because it gives drawings of eleven different forms of *Porites* with their localities; (2) because it records an observation which will help more than all our reasoning could do to break down an old-established custom, and put the whole method of coral taxonomies upon a scientific basis. For to Dr. Rathbun must belong the credit of first indicating the unit of classification of the future. Dr. Rathbun himself, however, endeavoured to continue in the beaten path; he allowed himself to be imposed upon by the supposed Lamarekian species. Only in the case of one encrusting form from Brazil did he rebel and declare that it was not *P. astræoides* (see p. 29); but all the many different branching forms (and how many, and how different, see for example his own figures) had to be ruthlessly forced into either *clavaria* or *furcata*. The difficulties experienced in having to decide into which of the two species some of the forms should go, forced from him the typical complaint of systematists who have to distribute their specimens among imaginary species. He regretted that so little knowledge about the specimens was available; fuller and better notes should be made by the collectors, notes which might possibly "*serve to show relationship*" in what is otherwise the blindest guesswork. The paragraph recording these all too familiar difficulties ends with the following: "Fortunately, in the last and largest collection received from Florida, all the specimens from each locality have been kept together, and it is shown that *each spot has its peculiar variety or varieties, differing more or less from all the others.*"

This priceless observation—which, let me add in passing, confirms at a stroke the conclusions to which the laborious work of writing these volumes had been slowly driving me—should, one would have thought, have instantly marked out the line of the work, for these "varieties" were clearly the units for the research. But, no! the imaginary species had not yet lost their hypnotic power. One more step had still to be taken before a real path was to be discovered.

This last step logically necessitated by Dr. Rathbun's work, was first perceived and eventually taken by Dr. Gregory.† It was clear, as above pointed out, that it was quite

* Proc. U.S. Nat. Mus. x. (1887) p. 354.

† Quart. Journ. Geol. Soc. li. (1895) p. 255.

arbitrary to crush so many structural differences into two species with such apparently small differences between them. An examination of the specimens in the U.S. National Museum showed Dr. Gregory that the supposed distinctions between *P. clavaria* and *P. furcata* were quite worthless. The natural conclusion, therefore, was that these two imaginary species had to be amalgamated as one, and, apart from the gradual accumulation of facts, which is valuable for all time, the work on the West Indian *Porites* had culminated in an imaginary proof that all the branching West Indian *Porites* were of one and the same species, and that that species had as its type the specimen from some unknown locality, and, I might almost say, with unknown calicle structure, which fell accidentally into Lamarck's hands, and was called by him *P. clavaria*!

This surely has the merit of "conclusiveness," not, however, as regards the systematics of the West Indian *Porites*, which was the subject in hand, but, at least it is to be hoped, as regards the method. It is obvious that the mere statement that all the many branching forms are all one species, which we should call *clavaria*, and that all the encrusting forms constitute a second species, which should be called *astræoides*, is totally without value. On its positive side it merely affirms that they are all related genetically, which is already connoted by classing them in the same genus; and on its negative side it denies the existence of any striking structural variations of *specific value*, a useless denial, because nobody knows what a "species" means, nor consequently what is the meaning of a "specific difference." We must refer the reader to the morphological section for an account of the structural differences revealed during the study of the forms for this Volume. He will find them both more extensive, in that the two obvious divisions into branching and encrusting is far too crude, and more striking than was supposed, supplying us with every indication that the future will reveal a wealth of variation hitherto undreamed of.

All then that has been attained by working for nearly a century with imaginary species, has been the conclusion that there are not three imaginary species, but two, which being also imaginary, leaves the simple facts just where they were. I am aware, of course, that it may be argued that, inasmuch as *Porites clavaria* and *furcata* were at any rate representatives of local forms, they were not wholly imaginary—not so imaginary, in fact, as *P. arenosa* (see p. 112) and *P. incrustans* (see Vol. IV. p. 117). That is true, and we have already dealt with that subject above, p. 5. But what are we to say of the use of the names *clavaria* and *furcata* as if they represented wide-spread, well-known species, while hardly a soul who used them had a chance of carefully studying and comparing them with the types regarded as local forms? They *need* not have been imaginary quantities, but they were so, inasmuch as no trustworthy figures * and no morphological diagnoses were available, and their localities were unknown; and without any of these they were empty names.

Only one writer has taken the subject in hand since Dr. Gregory showed that the old

* Except the one above referred to (p. 6) of Milne-Edwards and Haime, which, for reasons explained, appears to have been little consulted.

method led to a *reductio ad absurdum*. I refer to Dr. Wayland Vaughan,* who probably has a wider knowledge of the Stony Corals, recent and fossil, than any living student of the subject. His attitude is interesting. While formally accepting the perfectly logical conclusions of so distinguished a naturalist as Dr. Gregory,† he in reality sets to work to begin again. In passing, be it noted that instead of agreeing that all the branching forms should be called *P. clavaria*, he prefers to call them *Porites porites*, that name having the priority. With this altered general specific name, he begins to divide the forms according to their morphological differences in the following manner: *P. porites forma clavaria*, *forma furcata*, *forma divaricata*, and so on; while, further, he agrees with Dr. Rathbun in claiming that the name *astræoides* will not cover all the encrusting forms, and he again excludes the Brazilian form above mentioned. In addition to some excellent figures, which are a solid contribution to our knowledge, he further makes a valuable observation that the two branching forms found by him at Porto Rico, and called *forma clavaria* and *forma furcata*, were quite distinct and showed no signs of intergrading. This helps to confirm the observation of Dr. Rathbun, that there are distinct local forms.

I claim, then, that Dr. Vaughan has realised the necessity of beginning again and attempting to classify the different forms presented by nature. In that path I have followed, though my work has compelled me to clear the way in a manner which he did not attempt.

In the first place I have rejected the time-honoured names *clavaria*, *furcata*, *divaricata*, etc. They were the names suggested by the most obvious and superficial morphological factors—the first and simplest which came to hand. They were here necessarily given up, inasmuch as I found them crude and misleading. That they are misleading we have already shown (p. 6). That they are too crude can be seen by a glance at the Plates IX. to XVI. A perusal of these figures makes it at once apparent that such a multitude of different growth-forms could never be classified by such terms. Indeed, Dr. Vaughan's treatise above referred to is practically a confession of the failure of such names. The interesting branching forms from Curaçoa, one long ago figured by Seba (see below Pl. XVII. fig. 3), and the other discovered by himself, completely baffled him, and he could not decide whether they were *clavaria* or *furcata*, or what (l.c. p. 315).

In the second place, I have claimed to work independently of that whole tissue of species which has been drawn like an entangling network over the whole subject. Whatever basis of real fact may underlie the species—and the local forms may now be regarded as the long-sought-for reality, the existence of which was dimly apprehended in the meaning of the term—I regard the ordinary conception of them as "species" as, for practical purposes, wholly imaginary, because woven out of imaginary units. The genetic inter-relationships, which are the essential connotation of the "species," are far too vague and intangible, at least in the Corals, to form

* U.S. Fish Commission Bulletin for 1900, ii. p. 314. Dr. Duerden's excellent work on West Indian Corals is mainly developmental, and not systematic.

† Who, in his last great work on Corals (see Paleont. Indica, 9, ii.) expresses his regret that he did not throw over species altogether, so far as Corals are concerned.

the basis of a practical unit. The only real units presented to us by nature, are the local forms. I have attempted to begin the work again with these, hoping that little by little we shall discover their inter-relationships. And, as their method of designation, I name the units after their localities, and am disposed to assume that, just as these can be indicated by the localities in which they occur, so their larger groupings based upon discovered relationship will be ultimately expressible—at least for purposes of reference—in terms of larger geographical areas.

Morphological names being too crude and misleading, it seems to me that the local names so admirably indicate the only known and certain fact which distinguishes one member of the genus from another that it would be nothing short of a wilful obscuring of those facts to give the forms any other designations than those of the places where they occur. I am convinced that, as already stated above, p. 2, we shall have to begin our attempts to classify Corals as we first attempt to classify the human race, calling the units simply English,* Arabian, Chinese, etc. after the places they inhabit and from which they have spread.

III. MORPHOLOGICAL.

We have already mentioned the fact that the Atlantic and West Indian *Porites* form a group apart from that—or those—of the Indo-Pacific. A certain homogeneity characterises the former which at once strikes the eye as soon as any large collection is examined. To be able to notice it is, however, one thing: to describe it is quite another. This was indeed one of the problems we set ourselves to try to do, namely, to run down, by analysis, the secret of that subtle facies which differentiates the West Indian *Porites* from those of the rest of the world.

Whatever it might be, it presumably finds expression in three ways:—

1. There is a strange stiffness in the growth-forms, hitherto thought to present only two kinds, encrusting, and more or less freely branching. Although this is far too limited a description for the whole of the facts, yet the stiffness and want of plasticity of the West Indian *Porites* as compared with those of the Indo-Pacific region is quite startling.

2. There is an almost complete absence of any form which we could, unhesitatingly, call cœnenchymatous (see e.g. Pl. V. fig. 3). Such forms are especially numerous, and very highly specialised, among the Indo-Pacific *Porites*. See the list given in Table IV. Vol. V. p. 274.

3. There is a boldness and irregularity in the arrangements of the calicle skeletons very different from the delicacy and often perfect symmetry shown in the calicles of many Indo-Pacific forms. In spite of the almost innumerable variations of the latter, they hardly ever show calicles characteristic of the West Indian forms; while again, the calicles of the former are, on the average, larger than those of the latter.

When these differences are brooded over, they loom at first very large, and a vague suggestion that the forms of the two regions should be treated as sub-genera haunts the mind of the student. In this case, however, it was not listened to, because of the fact that the fundamental morphological analysis shows the two to be the same in every feature of structural importance.

* [See, however, Huxley, 'Forefathers of the English People,' *Nature*, i. (1870) p. 514.—Ed.]

It is, of course, possible that these differences may be quite independent of one another: each having some cause of its own. But it is obvious that, if we can find a cause sufficient to explain all three of them at once, that will in itself be some confirmation of the correctness of the explanation.

The conclusion so far arrived at by the author, is that the difference lies simply in the fact that the trabecular, horizontal, and synapticular elements which compose the skeleton are thicker and coarser in the Atlantic and West Indian forms than they are in those of the Indo-Pacific. There seems little doubt that this will account for all the superficial differences above mentioned. A glance at the magnified photographs will show the contrast in texture between the calicles of the West and of the East Indian forms. Several of the latter are shown on Pl. VII figs. 1-8, and one on Pl. I. fig. 1. The last named is given because it occurs at the Cape of Good Hope almost on the boundary line between the two regions, but itself belongs in its character to the Indian Ocean, see p. 25. A glance at these figures enables us to state that, generally speaking, the Indo-Pacific *Porites* show greater delicacy of the skeletal elements; that they are, consequently, far more plastic; and that the calicles, being fashioned out of a finer filigree, can not only assume a vastly greater number of shapes, including the proliferations of the walls seen in the cœnenchymatous forms, but allow also of greater perfection of pattern.

This delicacy of skeletal texture can sometimes be seen better in the sections, in the trabeculæ and the horizontal elements, or in the fluent networks which they form together. In the West Indian forms the trabeculæ and horizontal elements are mostly coarse and thick, cf. Pl. I. fig. 5*b*. Even when the surface elements of the calicles appear delicate, the delicacy may go but a very short way down, the surface threads will often be found to be standing up upon what look like flat flakes, but are in reality the elements themselves thickening rapidly. Such delicate surface skeletons are thin, as if arranged out of tissue resembling the wire-edges on blunt knives.

The fact, then, that the skeletal elements of the West Indian *Porites* are as a rule thicker and coarser than those of the Indo-Pacific is a matter of observation. That this difference will account for the other differences above referred to—the coarseness and want of symmetry in the calicle patterns, the scantiness of wall proliferations, and the stiffness in growth-form—hardly needs discussing. But whether this is the only cause I should not like to assert. Nor, again, can I account for the fact that the *Porites* of this region are so distinguished. If it were in the composition of the sea-water, one would expect to find some equally subtle differences between the members of other genera which have representatives in the two regions, perhaps also between the calcareous sponges, and even between the Molluscs. But, as far as I can gather, nothing of the kind has ever been noticed. We have, then, to leave the fact for the student of the future.

Coming now to the morphology of the West Indian forms themselves, we must not deceive ourselves into believing that, because this one common character separates them from the great mass of the Indo-Pacific forms, therefore we can treat them all as one, or perhaps two,

"species." There is no justification for the implication that they have no taxonomic problems of sufficient importance to trouble about. It is true that this has been the main drift of the work done on these forms until recent years, but, as stated in the historical sketch, our contention is that this conclusion is not based upon a close enough study of the facts, which could never be seen for themselves, but always through a haze of imaginary species. The problems are probably of greater interest and intricacy simply because they are thus circumscribed within narrower limits of variation.

The Growth-Forms.—We may again, as in the case of all the Poritidæ, start from small, slightly convex, "astræiform" * colonies as the first result of the budding of the parent, which forms the first "colonial unit" in the building up of the ultimate stock (§ IV. p. 20). All the subsequent growth-forms can be deduced from this, in the first place, according to the different rates of growth of its several regions:—if the edges grow alone, we have thin expanding forms; if the central regions grow alone, we have columns which may fork and branch: and in the second place, according to the way these colonial units multiply.

From the historical account above given it would appear as if these possible growth-forms were, in fact, extremely limited; confined to massive cakes (*astræoides* of Authors) and to branching forms called *clavaria*, *furcata*, etc. It is true that they are limited as compared with the marvellous wealth exhibited by the genus in the Indo-Pacific area with their smaller calicles, and more plastic (because more delicate) skeletal frameworks; at the same time they are not so limited as has been supposed; and, further, when more localities have been studied, it is to be expected that their range will be still greater than that which the following scheme can show:—

1. Expanding forms—

- a. Thin, with edges creeping over the substratum.
- b. Thicker, with convex or raised centres.
- c. Thick hemispherical or conical mounds. In these last the growth of edges and centre must be nearly equal.

2. Forms which start as expanding bases, from the surface of which one or more branching, or merely dividing, stems rise up later.

3. Forms the centre of which rise up at once as single stems upon disk-shaped bases. The stems fork, and, by multiplication of segments (see below, p. 20), produce branching stocks.

4. Forms which seem to rise up at once into egg- or pear-shaped stocks, and divide irregularly; the divisions are carried on by metamerie growth, and continue to swell as they rise.

Examples of all these are to be found among the specimens described in this Catalogue (see Table III. p. 130); while if we study Table II. we see how small is the area from which they have been gathered, and may thence reasonably infer that many more may ere long be added.

This scheme is already a great advance upon the results hitherto arrived at by the systematic work of my predecessors in this field, and it is an advance in the direction of closer analysis, while the discovery, made since this was first written, that these corals are built

* On the use of this term in this connection, see Vol. IV. p. 23.

up of at least two units, a calicle-unit and a colonial-unit, supplies us with a further instrument for that purpose (see below § IV. p. 20).

Hitherto all the forms included in the Division 1 (*a, b, c*) have been indiscriminately put together as belonging to the same species, *Porites astræoides*. It is quite impossible to deny that they *may* all be local variations of one and the same species, but that is an hypothesis which certainly does not advance knowledge one iota; on the contrary, it arbitrarily closes the book. Duchassaing and Michelotti thought that the encrusting and massive forms which they collected belonged not only to different species, but to different genera; and when we have no evidence to go upon at all, one hypothesis may be as good as another. We propose, then, to leave the question of species altogether out of account, and analyse the known forms, in order to discover, if possible, some definite principles of growth other than the mere fact that the forms are encrusting as opposed to branching. The result has been that, besides the three subdivisions 1*a*, 1*b*, 1*c* mentioned above, it is possible, as we shall now see, to distinguish surface markings, with a definite principle of growth underlying them.

The principle is as follows: The mounds or eminences which appear on any normally growing thick encrusting or massive form, repeat the shape of the initial stock. Or we may say that the shape assumed by the initial colony of any such *Porites* will be assumed again by every group of polyps large enough and well enough placed upon the surface of the colony as it grows larger and larger. As illustrations of this, we refer to the following:—

Pourtales' * splendid figure of *P. Florida* 6 (see p. 75), which shows a smooth hemispherical mass covered with equally smooth hemispherical eminences.

Dr. Vaughan's † photograph of *P. Porto Rico* 5 (p. 65) shows a rough hemispherical mass looking like the bark of a tree, covered with eminences of exactly the same character.

P. Belize 3 (p. 69, Pl. XVII. fig. 7*a*), which has a long ovate outline, and tends to rise like a rounded angular wave; the surface is raised all over into eminences of this same shape.

P. West Indies x. 28 (p. 104, Pl. XVII. fig. 11) rises into an almost round-topped conical mass, and the whole surface is covered with vertical round-topped upgrowths.

P. St. Domingo 1 (p. 66) rises like a peaked mountain mass, and the whole surface is covered with peaks.

While I admit that these cases are not numerous, they are so clear and exact that we are fully justified in maintaining that they point to the existence of some definite principle of growth in coral stocks, which has never previously been noticed. It seemed at first as if it could be expressed somewhat as follows: that the form assumed by the initial colony is always endeavouring to repeat itself on every suitable surface of the resulting stock. This seems simple enough, and the connection it has with the more comprehensive law of metamerism growth, to the discovery of which it led, is obvious.

The Branching Forms, Divisions 2, 3, 4.—Leaving the astræoid forms, we pass now

* Florida Reefs, Mem. Mus. Comp. Zool. (1880) pl. xvi.

† Bull. U.S. Fish Commission, ii. (1900) p. 289, pl. xxxii.

to the branching forms. The union of all these under one species, "*P. clavaria*," by Dr. Gregory under one species, "*P. Porites*," with three *formæ*, *clavaria*, *furcata* and *divaricata*, by Dr. Vaughan, was in reality a confession of despair at ever being able to find any growth principles according to which they might be classified. Dr. Vaughan's *formæ* suggest a rough grouping according as the branches are thick and clavate, or thinner and more openly forked, or again very thin and divaricate. This division, as far as it goes, is certainly a step in the right direction, although it is necessary to caution the student against any confusion which might be caused by the use of these names. For, as already stated (p. 5), Lamarck's two names, *clavaria* and *furcata* were not meant to imply any such contrast between his type specimens as is clearly meant by the current use of the terms. It is, however, only a very small step, for it is far too crude, and there is no wonder if upon such a rough-and-ready method of division, large collections show almost unlimited intergradings.

Fortunately our study of the forms in the National Museum, as well as in the Natural History Museum in Paris, compared also with the excellent figures published, among others, by Dr. Rathbun and by Dr. Vaughan, shows that a law of repetition of growth prevails among the branching, as well as among the encrusting and massive forms.

Referring to Divisions 3 and 4, the one rises from a small disk, which acts as a basal plate to a cylindrical stem, while the other rises at once, and swells as it rises. Both of them attain a certain height, and then divide, forking at various definite angles, and showing different kinds of division. Now my experience is that whatever the angle and the kind of forking in the first instance, there is a tendency for the same to continue, and at the same intervals apart, throughout all the subsequent growth of the stock. This repetition is perhaps more difficult to establish than in the case of the explanate massive forms, because not only are growing branches more exposed to external influences, but mutual interference is certain sooner or later to necessitate modifications. The principle can however be traced in most forms, while in young stages, say for the first two or three successive forkings, it may be quite conspicuous. One very startling case, though of only two successive forkings, with faint indications of the third, may be cited in *P. West Indies* α. 14 (Pl. XIII. fig. 3). In this case each prong of the fork is twisted a little, not only on itself, but also out of the plane within which the forking, in order to be rectangularly symmetrical, should have taken place. This double twist occurs in the first forking, is repeated again almost exactly in the second, and is already quite traceable in the beginnings of the third. This case of such exact repetition is very remarkable, and, owing doubtless to the scarcity of young branching forms showing the initial stages of branching, is not easy to confirm by the production of examples equally striking. The majority of our specimens are fragments of old stocks, often growing upon overturned earlier growths, and such like. But when we find a complicated twist, which might easily be attributed to an accident if seen on one prong of a fork alone, not only produced by both prongs, but by both prongs for two and even apparently three successive forkings, its significance, as indicating some law of repetition in growth of the successive parts, cannot be overlooked.

Another somewhat striking case is supplied by those forms which swell as they rise. Of these there is one minute egg- or pear-shaped initial growth * which has not yet begun to show signs of forking, and several adult stocks. These adult stocks can be seen to have the same character throughout. The forking is as nearly as possible at the same angle, usually very small; the stems steadily thicken, their tips swelling and dividing mostly into rounded knobs, the forking becoming more and more irregular as the fusions increase in number. But as they all rise from very small bases they must apparently all sooner or later tumble over unless the great lateral expansion of the whole practically forms a new support sufficient at least to keep it from falling far. Pl. XVI. fig 1, is a sample of such a growth. Pl. XIV. fig. 5 is another with very irregularly thickening stems. Pl. X. fig. 2 shows another on a very small scale. *P. Porto Rico* ♂ figured by Dr. Vaughan appears to show the same (see further Table III., E. d. p. 136).

In passing, and in connection with these forms, which swell at once above a minute base, I should like to call attention to the one figured by Duchassaing and Michelotti, and called by them "*P. macrocephala*" (see p. 89). Though the figure shows some irregularity in the style of upward growth, one portion, at any rate, swells into a blunt inverted cone, which appears to have suggested the original name. While it is doubtful whether this is normal, there is little doubt that such forms might well be developed as an extreme of such forms as those shown on Pl. XI. figs. 4 and 5, which are further illustrations of stocks built by a repetition of swelling, pear-shaped up-growths.

Now these cases appear to show that the principle of growth, described above as apparently applicable to the massive explanate forms, is true for the different kinds of branching stocks as well. Only we now gather that each joint of a branching *Porites* is as nearly as possible a repetition of the original stem, that is practically of the initial colony minus its basal disk (which is no longer necessary), and repeats its height, its method of division, and its angle of forking.

In the absence of such direct proof as we might have obtained from a large series of growing stages, we call attention to the fact that in no form is the branching wild and variable; the character of each form is always true throughout whether it is large or small. Further, a point of special interest is the fact that the stems between successive forkings frequently vary in thickness (e.g. *P. Curaçoa* 1). There seems, as a rule, to be very little gradual thinning away of the dichotomously branching stems from below upwards, which there would be if the whole were a complete unit of growth. The terminals are often almost as thick as the adult portions, and any particular forking section may be even somewhat thicker than the initial stem, or, what is the same thing, than any one below it. This suggests that each such section is a repetition of the initial or basal stem, some a little better nourished, some a little worse.

If this is true of the West Indian *Porites* as a fundamental growth principle, it is difficult to believe that it is confined to the West Indian forms alone; one would expect it to be universal. As a matter of fact it was only suggested by one of the Indo-Pacific forms, *P. Ceylon* 4, see Vol. V. p. 266; although it is probable that if the series could be worked over again it would

* *P. Barbados* 10, p. 42.

be almost as clear throughout as it seems to be in these West Indian forms. I say "almost" because there is an admitted stiffness of growth shown in the group here dealt with, which contrasts with the plasticity of the Indo-Pacific forms.*

Referring the reader to § IV., p. 20, for further discussion on this elementary growth-principle we turn to a brief review of some of the variations shown in the forms of the branchings tocks.

The possible variations in method of forking are, of course, very great, even assuming that the division is always into two, whereas, in passing, it may be noted that here and there (*e.g.* *P. Florida* 1, Pl. XII. fig. 2) there are *traces* of division into more than two, traces which require further investigation. The vast majority of the forms noted in this Volume certainly divide typically into two prongs, and only two.

There may be endless differences of height, thickness, and roundness of the initial or basal stem. If thin and long, their repetitions result in thin open stocks, branching only at considerable distances apart. If the forking is at a small angle, the stock towers upwards; if the angle is wide, the stock is divaricate. If the initial stem is very short, forking almost immediately it rises above the ground, stunted almost nodular stocks may be produced; and so on. While this repetition is the essential principle underlying the growth-forms of the West Indian branching *Porites*† and supplies us with taxonomic characters for their comparative descriptions, certain interesting modifications have to be noted, modifications which may be seen to be quite natural on the principle above laid down. The most important is the habit of aborting one prong. The one which survives is, as a rule, that which is nearest to the vertical, and into it the vegetative energies of the colony are concentrated, thereby insuring the successful upward growth of the stock. A reason for this abortion, at least in certain cases, may perhaps be found in the fact that a position far out of the vertical is not favourable to the growth of the prong, treated as a new unit and trying to repeat the initial or basal colony; hence its inability to grow. These aborted prongs may be found in all stages from knobs, small mammillate processes, or as mere bends in an apparently smooth stem. We would explain the mammillate processes on such an extreme form as *P. Barbados* 6, Pl. IX. fig. 5, as due to the abortion of lateral prongs, with the result that the stem seems to shoot up as a single, tall, thin, tapering rod.

The abortions of prongs which lead to bends in the smooth stem, bends which may become very characteristic of certain forms, are always referred to in the descriptive text as "knee-bends." *P. Porto Rico* 4† shows many examples of them. In connection with such bends and distinct from them, although at times they may be difficult to distinguish, are the natural phototropic upward curvings of prongs which have been turned outwards too far from the vertical. This is very pronounced, for instance, in the type specimen of Lamarck's *P. furcata*, preserved in the Paris Museum, see Pl. XII. fig. 1.

It is true that it will be long before we shall have discovered the growth-principles of all

* There is certainly one *Goniopora* (*x. h.*, p. 161) described in the Supplementary Catalogue of that genus given in this Volume, which shows the same phenomenon in almost as striking a way as does the young *Porites* (*West Indies x. 14*) above described.

† See Dr. Vaughan's excellent illustration, Bull. U.S. Fish Commission, ii. (1900) pl. xxx.

the known forms and succeeded in arranging them into groups according to these principles. We have seen that the crude method of grouping according as the branches are what is meant by clavate, furcate, and divaricate completely and confessedly breaks down. We do not pretend that the methods of analysis here laid down are anything like complete. All we claim is that a beginning is here made which, at least, promises to carry us some little way towards a natural classification. One distinct group may, for instance, be seen in the forms above mentioned (p. 17), in which the initial stock rises directly into a gradually thickening knob. They all seem to show close clusters of sinuous stems forking and thickening as they rise. We have apparently a progressive but irregular thickening of the successive units with abortions of prongs or smooth "knee-bends." It seems safe to assert that they all differ inasmuch as their initial colonies were different. For a further analysis of the growth-forms see Table III., p. 130.

We turn lastly to the most difficult feature of the West Indian corals. Differences in growth-form may for a while escape our analysis, but eventually yield to a careful comparative study. The differences in the calicles are far more subtle. However, with the assistance of the diagrams published in Vol. V. p. 14, and reproduced on p. 139, we can make a small beginning (see further Table IV.).

The Calicles.—We have already noticed that, as compared with the Indo-Pacific *Porites*, the calicles of the West Indian forms are coarse and irregular, owing to the thickness and consequent stiffness of the skeletal elements. It is quite possible to find Indo-Pacific forms with calicles as large, coarse, and irregular as almost any West Indian form, and perhaps even some of the latter which show something like the same delicacy and wealth of detail as a few of the former; but on the average the difference is as described. It was this precision in the detail of the calicle skeleton in the Indo-Pacific forms which enabled us, as soon as the principles of structure were made out, to make some approach to arranging the calicles into groups according to structure. It is doubtful whether any such approximation could have been made had we had the calicles of the West Indian forms alone to work with. Even the fundamental formula of the septa could hardly have been made out without a previous knowledge of it obtained from our study of the Indo-Pacific forms; while, again, the raggedness of the surface skeleton makes it difficult to analyse the wall-formation. This task was comparatively easy in the case of most of the Indo-Pacific forms, and we were able to base a classification of the calicles upon the number of rings of trabeculæ which take part in the separation of adjacent calicle-cavities.

Applying this same system of analysis to the West Indian forms, we may note, first of all, that the Diagram B, fig. 1, p. 139, which was applicable to only a small proportion of the Indo-Pacific forms, viz. to those in which the walls were zigzag, represents the condition seen in the vast majority of the West Indian forms. In this respect there is a uniformity in the calicles which has certainly greatly added to the difficulty of classification; nevertheless, differences of other kinds can generally be found: the height of the wall and the varying character of its elements, the different characters of the septa, and the stiffness or fluency of the

network of which the calicle skeleton may, for practical purposes, be regarded as a modification.

One other factor deserving of note in the West Indian forms is the obscurity at first sight, of the septal granules (*sg* of the diagrams). They seem to be frequently confused with the zigzag walls, or else to be but slightly developed. In specimens of the astræoid * group they can be frequently only just detected as faint thickenings of the short septa (see, however, the treatment of these granules in Table IV.).

There are, however, a few cases in which the characteristic zigzag is replaced by thicker reticular walls. Both kinds can often be seen on the encrusting and massive forms. On surging-up mounds the walls are thick; in the valleys they are thin; while again, others are thick all over, e.g. *P. Belize* 3 (Pl. I. fig. 7); *P. West Indies* x. 15 (Pl. V. fig. 3).

One observation deserves mention, viz. that when foreign objects come too near the surface of a colony and the natural functions of the polyps are interfered with, the walls tend to proliferate. *P. Bahamas* 1 shows two patches: one a perfectly flattened area due to the proximity of some foreign surface (in this the wall has proliferated in flakes, see Pl. IV. fig. 3); and a second, where the polyps of a *Mussa* came into inconvenient proximity with those of the *Porites*, with the result that the normal skeleton of the latter is changed from that shown in Pl. IV. fig. 2 to Pl. IV. fig. 4, in which the proliferation is finely filamentous. It is certainly instructive to find on one and the same specimen two such different results due to the inconvenient proximity of foreign bodies and organisms (see further Table IV.).

IV. FURTHER EVIDENCE OF THE METAMERIC GROWTH MENTIONED IN THE FOREGOING SECTION.

In the last section we found traces in *Porites* of a principle of growth not hitherto recognised in the Stony Corals. It would not be true to say that no instance of it has been known, for, as we shall see, the most prominent instances of it have already attracted attention and provoked discussion. Nevertheless, the principle as a principle has not hitherto been recognised, and consequently, its significance for the understanding of the general morphology of the Corals has been entirely missed.

The principle is this, that each stock begins with its larval parents, and by gemmation produces its initial colony and assumes some characteristic shape. This initial colony is incapable of indefinite growth, but at a certain period, differing doubtless with each form, undergoes some process of repetition, further details of which will be mentioned below. Just as the initial colony was built up by the addition of calicle units, the adult stock is built

* Used in the sense given on p. 142. The term, always in this Volume, refers to the character of the calicle, and not to the growth-form; although, as far as I know, such calicles are only found on massive forms.

up of colonial units. Indeed in the active formation of any coral stock we have three units of structure; cells build up the calicles, the calicles build up the colonies, and the successive colonies build up the stock. We are here concerned with the two latter units alone.

The Stony Corals then exemplify the growth-principle called by zoologists "metamerism." It differs from ordinary gemmation, which means budding generally, in that it is serial; and it differs from sexual reproduction in that the latter begins the new organism *de novo* from sexual cells, whereas gemmation of one multicellular organism from another is, I take it, a very specialised form of fission, in which the area affected has been secondarily limited and circumscribed, so as not to cripple the functions of the parent so completely as true fission—that is, fission into two equal parts—would do.

In metameric stock building the "budding" of the units is serial, and the following conditions might occur:—

1. The parent—which, in the corals, may be a single adult or a colony—having budded may die down, and the total result is a succession of organisms piled up on one another, the last of which is the only one living.
2. A second, higher stage would be reached when the parent forms die away more slowly and progressively, so that large stocks are produced in which an indefinite number of the more recent units are alive at one and the same time.
3. A third stage would be reached when these living units become co-ordinated together for mutual aid and common action, defensive and offensive; while lastly—
4. A fourth stage would be reached when the generations cease to appear as separate generations, but merely as segments, and even vestiges of segments, and what was really a succession of asexual generations becomes as one organism.

With reference to these stages, it is clear that the early death or continued life of the parents must largely depend upon the shape of the organism; if, being sessile, it is flat like a plate, the bud is bound to smother the parent; if it is of any other shape, the parent has some chance of further existence; while if the organism is free-swimming the whole colony might live and move as one organism.

These principles can be shown to have played a great part in the building up of the larger living organisms, and in many it is still traceable in the result. In the vegetable kingdom we point to the trees and the grasses as forms obviously built up by the repetition of parts. In the animal kingdom we may point to the Polyzoa, and to the worms with their many segmented derivatives, Insecta, Annelida, Crustacea, and, as some think, the whole of the Vertebrata. In the first three of these latter we find all stages in the gradual obliteration of visible segmentation with increasing concentration of function. The animal group which, however, here most interests us is that of the Coelenterates, to which the Stony Corals belong.

In this primitive group, growth by gemmation is one of the most striking methods of reproduction; there are many variations of it. The buds may adhere and form branching stocks; some may break away as sexual individuals. Others build up free-swimming stocks,

in which concentration of function is advantageous, and the whole stock may acquire a high degree of organic unity (Siphonophora). While lastly the well known strobilation of *Aurelia* may certainly be regarded as some very specialised variation of the same process. Now, since the Stony Corals belong to this same group, it might have been expected that this same principle would assert itself in spite of the secondary secretion of hard calcareous skeletons. These skeletons might lead to variations of the process, but not prevent it altogether.

It is, of course, impossible here to attempt a review of the group: a few examples must suffice. Let us then in the first place consider the large fossil solitary corals, whose stocks at the very first glance suggest the strobila of *Aurelia*, although it is also obvious that they are in reality variations only of the same process. In the cases we refer to, the polyps, when they reached their full size, appear to have budded, and the bud to have repeated the form of the parent and to have secreted a skeleton like that of the parent just where it was, on the top of the one from which it sprang.

In this way these fossil stocks show series of skeletons, like rows of saucers or cups, one in the other—rows which are sometimes of great length. Such cases are examples of the budding of single adult organisms and the consequent formations of stocks, the very last individuals of which were alone alive.

Considerable interest attaches to the way in which these skeletons rest upon one another, although we can assert little about it—it needs investigation. We may say, that however irregularly it began, it is certain that little by little the skeletons of the buds gradually acquired the power of attaching themselves to the parent skeleton in such a way as to continue its form and symmetry. We may, perhaps, correlate this with the rise and development of the septa, over which the new ectoderm of the bud would naturally bend, and in the folds thus produced commence to secrete its own septa. The coincidence, or rather continuity, of the peripheral walls would probably be brought about more easily in the deep conical forms than in the shallower saucer-like forms. And if memory does not deceive, the fossils which show very *irregular* piles of calicles sitting in one another are most frequently found to have shallow saucer-shaped calicles.* When this process is complete, that is, when the skeleton of each generation appears simply to carry on the skeleton of its parent symmetrically, the only trace of the process in the fossil would be in the series of tabulæ.

If this is a true account of the phenomenon, that the earlier cruder form of metamerism with its piles of obviously discrete calices, passes gradually into a continuous skeleton, the original segments of which are now so disguised as to be seen only in the succession of the tabulæ, we shall have, in the formation of every such coral, to distinguish *two methods of growth*. In the earliest stages of its individual development the growth will be normal growth *de novo* from the larva, with the gradual withdrawal of the expanding polyp from the cup which is progressively too small for it. This results in the deposition of *one* series of tabulæ. When the

* I am indebted to Mr. W. D. Lang, of the Geological Department, for calling my attention to the interesting case of *Parasmilia* of the chalk in which the successive calicles fail quite to fit into one another symmetrically.

normal size of the adult is reached the growth is different, and can no longer be described as a growth of the individual with withdrawal of the enlarging polyp from too small a skeleton, but the deposition of a new skeleton upon the framework of the old, the new skeleton belonging to a new individual polyp which comes into existence in some way by gemmation from the old, but the only visible sign is still seen in *another* series of tabulæ, differing from the first in that there is now no increase in the diameter of the stock.

We find, then, in these so-called solitary corals, that they are also in reality colonies—produced by gemmation—in which, however, only the last member of the series remained alive. This explanation so far appears fairly satisfactory: at the same time this is not the first time the phenomena they present have been discussed, but it seems hitherto to have been mainly attributed to some peculiar method of rejuvenescence (“*verjüngung-process*”). If the linking on of this process with gemmation, as here suggested, will stand the test of further inquiry, that term will hardly be necessary.

From these solitaires we pass to what are ordinarily known as colonial corals, and we find distinct traces of the same metameric growth. These colonial forms must therefore be regarded as the result of two distinct kinds and periods of gemmation or colony formation. Let us suppose that one of these large flat saucer-shaped calices of Palæozoic times divided up into a colony of small calices; the stock would then consist of tiers of small disk-like colonies, and we should get an almost exact reproduction of what we actually find in life, e.g. in the genus *Goniopora*. Indeed without having perceived the meaning of the phenomenon so clearly as I do now, I have already shown † the apparent homology between the metameric reduplication of single calices such as is seen in *Montlivaltia* with their successive bands of epithecal films (cf. the tabulæ), and the succession of growth periods in *Goniopora* with their closely similar bands of epitheca, which are again obviously the edges of tabulæ (see Vol. IV. of this Catalogue, p. 24, Diagrams A, B, C, D). In this last named genus we have the growth method here discussed exemplified in a very striking manner; for, on attaining a certain size, the initial Gonioporan colony is always grown over by another, with a distinct edge, and consequently with its own epithecal rim.

The whole phenomenon has been a standing difficulty to me, and until now I have seen no solution, although I have puzzled over it many times. It was especially difficult because each colony was apparently grown over by another, and that by another, into a series of colonies one on the other. This was obvious from the many distinct edges, yet a section showed the whole series continuous throughout, *the trabeculæ running smoothly through the whole*.

How, I thought, is it possible to have a new and distinct colony with its skeletal elements *continuous* (except, perhaps, at the edges) with those of the skeleton on which it grew? We can now say that it is only another case of the continuity of the skeleton of the bud with that of the parent, such as was described above for the fossil solitary corals. The matter is here,

* Milashevitch, *Palæontographica*, xxi. (1876) p. 223; *Tomes, Geol. Mag.*, 1888, pp. 208–9

† *Ann. and Mag. Nat. Hist.*, 7^o xiii. (1904), p. 9.

however, somewhat more complicated. For it is not one polyp budding from another, but a colony, consisting of a multitude of polyps which bud simultaneously from the surface of a previous multitude, and they fit so accurately over one another that each new polyp continues the growth of the skeleton of its corresponding polyp of the former colony. This is certainly one of the marvels of growth which not only baffles our powers of conception, but demands investigation, if for no other reason, at least to ask how it fares with any intercalicinal buds. Are they repeated just at the right age and stage in the new generation? The process requires the assumption of something more than a new bud: some extensive process of histolysis would alone suffice, in which an old colony begins to die down, undergoes some very extensive internal re-organisation, and starts again, an entirely new colony, which fits so accurately into the skeleton of the old, that, beyond secreting a tabular floor by its own new ectoderm, no break can be seen in its skeletal continuity. We once more ask whether this is the real explanation of what we have always referred to as repeated withdrawal of the polyp as the skeletal walls grow in height; or do both processes occur consecutively, as suggested above for the large fossil solitaries?

Here are matters of the first moment for the coral morphologist. They require investigation. As probably some contribution to it, I would call attention to an interesting observation of Professor Duerden's,* of which he offers no explanation. He noted individual stocks, especially of "*P. astræoides*," of which all the polyps seemed to be in a state of maceration, though others living around them were perfectly normal. They appeared to be "alive and normal in colour, but upon examination with a lens no distinct polyps or tentacles were recognisable. The whole of the soft tissues seemed to be a gelatinous mass in process of decay, the coloration being due to the persistence of the yellow pigment cells characteristic of this species."

Is it not possible that this strange condition indicates some internal reconstitution of the organism into fresh individuals which build symmetrically upon the old skeleton? It is to be hoped that ere long colonies, in the condition described by Professor Duerdin, will be submitted to minute microscopic observation. It is apparently a kind of budding, so specialised that the parent is entirely absorbed by the bud which in every respect repeats the form of the parent—a process explicable only by referring it back to the more primitive fission.

It remains for us here to add that, though the discovery of this new principle of growth must sooner or later make itself felt in coral systematics, no use of it has been made in the systematic portion of this Volume, inasmuch as it was not discovered till the descriptions were all in print. Some reference, however inadequate, is made to it in the Table III., which deals comparatively with the growth-forms of the specimens here described.

* "The coral *Siderastræa*," Washington, 1904, p. 18, published 1904 by the Carnegie Institution.

GEOGRAPHICAL ARRANGEMENT OF THE ATLANTIC AND WEST INDIAN PORITES.

Group I.—WEST AFRICAN COAST AND CAPE VERDE ISLANDS.

We begin the systematic review of the West African specimens with a brief notice of the only known form which occurs where the Indo-Pacific and the Atlantic regions meet (*P. Cape of Good Hope 1*). A description without a figure was given in Vol. V., p. 231, and it was there pointed out that the form was probably found in False Bay, that is on the east side of the Cape point, where the temperature of the water is several degrees higher than on the Atlantic or west side. It is here figured (Pl. I. fig. 1), because it illustrates at a glance the difference in habit between the Indo-Pacific and the Atlantic forms, which has been referred to in the morphological section, pp. 12 and 13. On the other hand, the fact that this form illustrates the Indo-Pacific type helps to justify our having regarded it as belonging to this latter and not to the Atlantic group. Further, inasmuch as the growth forms of the specimens are thick, encrusting cakes, we might have concluded that, had they been Atlantic forms, they would have shown some approach to the *Astræoid* * habit. We find, on the contrary, that their skeletons are built up of comparatively thin delicate trabeculae closely packed, and rising to form thin walls and pali, of which latter only the four lateral principals are at all conspicuous. There can be no doubt, then, that this form belongs to the Indo-Pacific group, though it occurs on the border line between the two regions. It shows no trace of transitional characters, although it is perhaps only right to add that if it did it is doubtful whether we should have been able to recognise them in such an intricate and subtle morphological complex as the *Porites* skeleton.

1. *Porites* West Africa 1. (*P. Africana Occidentalis prima*.)

[The Gaboon; Paris Museum.]

Description.—The corallum is very thin and encrusting, with edges under 1 mm. thick, and supported by stout wrinkled epithecæ.

The calicles are small, the larger about 1 mm. in diameter, angular, and flush with the surface. The walls consist of thin, wavy, not zigzag, threads, which are sometimes flattened

* On the use of this term in this Volume, see p. 142.

horizontally into flakes, the edges of which seem to be run out along the septa. The latter are prominent, crooked, nodulated or angular, and fuse into the typical four pairs and ventral triplet. The pali are but feebly developed as slight swellings at the points of fusion. A small columellar tubercle is here and there seen, but no tangle is visible; the fossa is consequently deep and open, as are also the interseptal loculi. The skeleton consequently appears to have a loose, open texture.

The locality of this *Porites* (No. 197 bis *a* in the Paris Museum), far from any known coral reef, and its flattened under surface suggesting that it rested on some soft, perhaps muddy, bottom, are not the only interesting points about it. We have to note its thread-like walls and feeble pali as indicative of the greater development of the horizontal than of the trabecular elements. This character helps to unite it with the other Atlantic and West Indian forms as against the Indo-Pacific, including the specimen from the Cape of Good Hope with its tall, thin, trabecular walls.

There are in all three specimens; the above description is based upon the one with the smallest calicles; the two others were obscured by animal matter, which made it difficult to examine the details.

2. *Porites* Cape Verde Islands 1. (*P. Insularum Arsinarii prima*.)
(Pl. I. fig. 2; Pl. XVII. fig. 1.)

[St. Vincent, coll. H.M.S. 'Challenger'; British Museum.]

Syn. *Porites Guadalupensis*, Quelch (*non* Duchassaing and Michelotti), Chall. Rep. xvi. (1886) p. 181.

Description.—The corallum is thick, encrusting, and with a tendency to throw out laterally rounded lobes like the blunt pseudopodia of a great amoeba.

The calicles are about 1.25 mm. in diameter (but of very different sizes), deep, mostly rounded, but here and there drawn out of shape. The walls stand up steeply, built of very irregular trabeculae, here thin, branching and ragged, there membranous. Their top edges are filamentous, either as a very slight or else as a very pronounced zigzag; in the latter case, the wall looks thick. The septa begin as short thin filaments projecting from the angles of the zigzag; they lengthen very gradually and meet in a tangle, which, deep down, forms an irregular floor to the fossa without any conspicuous traces of the typical septal arrangement; slight traces here and there of pali may be seen, but the typical formulae are nowhere completed.

In vertical section the irregularity of the trabeculae is the most conspicuous feature; thick and nodulated, deep down, they thin away near the surface into an irregular network in which they cease to be conspicuous elements.

The colour seems to have been a dark ochre.

Mr. Quelch described this coral as closely allied to the massive Red Sea forms "*arenosa*" and "*conglomerata*": But in this form, though trabeculae carry up the walls to a considerable

height, they are very irregular and unlike those of any of the Indo-Pacific forms. The ragged walls have a general habit not unlike those of a small *Alveopora*. It is not the *Porites* called "*guadalupensis*" by Duchassaing and Michelotti, after the island where it was found; see the description and figure of that form, p. 45, Pl. II., figs. 2 and 3, which more closely resembled the typical *astræoides* of authors.

Specimens of this coral associated with the next occur in rock pools, forming bright yellow or pinkish-white rounded masses.*

a.

Zool. Dept. 80. 11. 25. 18. (part).

3. *Porites* Cape Verde Islands 2. (*P. Insularum Arsinarii secunda.*)
(Pl. I. fig. 3; Pl. XVII. fig. 2.)

[St. Vincent, coll. H.M.S. 'Challenger'; British Museum.]

Syn. *Porites superficialis* Quelch (*non* D. & M.), Chall. Rep. xvi. (1886) p. 182.

Description.—The corallum is encrusting, and, by enveloping foreign bodies, forms rounded nodules with smooth surface flattened here and there into facets. The epitheca is everywhere visible round the thin edges.

The calicles are visible owing to the slight irregular pitting of the fossæ, though without sharp outlines to the pits; these are very variable in size, the larger being about 1.5 mm. The walls are low and broad, and are built up of horizontal, finely cut flakes perforated with rounded pores; down the sides of the stock the uppermost layer of flakes tends to be rather more filamentous. The septa run out long, straight and narrow (that is, losing their flaky character) from different levels of the wall flakes, and have regular smooth fine echinulæ projecting from each side. The echinulation of the septal edges is in striking contrast with the smoothness of the pores and the excisions in the edges of the wall flakes. The septa fuse irregularly above a large, solid-looking plate, which early closes the base of the fossa. Pali are hardly traceable, but a slight very irregular columellar tubercle may appear in the shallower calicles round the creeping edges.

The original description of *Porites superficialis* from St. Thomas (see below p. 59) hardly agrees with this, for its septa were laterally smooth, or hardly echinulate; whereas the septal echinulæ are here pronounced.

This again hardly fits in with the *P. astræoides* group, which is the only species established by Drs. Gregory and Vaughan for the West Indian, and I may add Atlantic massive and encrusting *Porites*, see Introduction, p. 10, nor is it one of our *astræoid* group, (see p. 142).

It is described as occurring in rock pools in association with the form last described (v. footnote).

a.

Zool. Dept. 80. 11. 25. 18. (part).

* See Moseley, "Notes by a Naturalist on the 'Challenger,'" p. 48. Quoted by Mr. Quelch.

4. Porites Cape Verde Islands 3. (*P. Insularum Arsinarii tertia.*)
(Pl. I. fig. 4.)

[St. Vincent, coll. Lowe, Rev. R. B. Watson ; British Museum.]

Description.—The corallum rises into stout irregular stems, 2 cm. and more thick; the complete form and method of branching are unknown.

The calicles are deep and conspicuous, varying from 1·5 to 2 mm. in diameter; smallest and deepest near the tips. The walls are irregularly zigzag threads from the angles of which short, irregular septal rods project; these may be thick, rough and echinulate, and of such different lengths that some few of them meet and fuse high up, while the majority slope only gradually inwards to join a large columellar tangle. From this granules, minute, irregular and only showing traces of the typical formula, arise and represent pali and a central tubercle.

The vertical section shows stout, very irregular, and inconspicuous trabeculæ, with rows of round pores between. These pores are large or small according to the degree of compactness of the skeleton, which is naturally strongest and most solid near the base.

There are two fragments. One (*a*) the tip of a broad stem, 3 cm. long, and flattened as if about to divide up into 3 prongs. The other (*b*) is an irregular stem, about 8 cm. long, which seems to have been a detached fragment when discovered, for one side has been killed down and the living layer of the upper surface tends to creep down on each side over the dead portion. Both fragments have the same kind of calicle with large deep circular fossa, but the smaller (*a*) has a lighter network and consequently a more open columellar tangle, and larger pores between the trabeculæ in the section than *b*. In this latter the columellar tangle appears nearly solid, and the pores in the section are very small; the short nodulated trabeculæ fusing together render the section of the older part nearly solid. The surface of the basal region of *b* is somewhat remarkable, for, seen sideways, the trabecular elements tend to rise as such above the surface, many of them with round knobs, as if their skeletal tips were dying down and being corroded.

a and *b*. Fragments in a box together.

Zool. Dept. 79. 5. 28. 22.

Group II.—BRAZIL.**5. Porites Brazil 1. (*P. Braziliensis prima.*)**

[Recife do Lixo, Abrolhos, and abundantly at Porto Seguro, coll. C. F. Hartt;
Yale College Museum.]

Syn. *Porites solida* * Verrill, Trans. Conn. Acad. i. (1868) p. 359.

Description.—The corallum is encrusting "or" massive, rounded, with uneven surface, and spreading margin "covered with" (? = supported by) a strong epitheca.

The calices are unusually large (2 mm.), deep, well-defined and sub-circular. The walls are "rather" thick, acute, and "divided into" spinous processes. The septa are nearly equal, well developed, rather wide, their inner edges perpendicular and irregularly toothed, their sides scarcely roughened. Pali not distinct. The columella is well developed as a solid floor to the fossa, and is surmounted by a small tubercle.

Dr. Verrill thought this was distinguishable from any other West Indian *Porites*, but came nearest to *P. Guadalupensis* of Duch. and Mich. (see p. 45). Dr. Vaughan would regard it merely as a specimen of *P. astræoides*, which is one of the two "*species*" into which he would divide the whole of the West Indian massive forms (cf. next form *P. Brazil 2*). Not having seen the specimen myself, I can pronounce no opinion except upon the general principles involved, already referred to in the Introduction, p. 10 and p. 14, where it is shown that, as our morphological insight deepens, differences, now unperceived, are likely to be discovered, and that it is safer to label the specimens from the places they come from than, *assuming* that the differences, if any, are unimportant, to put them all into one species. This is not classification, but the negation of it.

It is quite possible that the designation *P. astræoides forma Braziliensis* might be better than *P. Brazil 1*. But I cannot recommend it, on the ground that there is no evidence whatever to lead us to believe that all the encrusting forms constitute a group apart, genetically distinct from all the branching. The fact that transition forms occur (see p. 14) points the other way. See p. 142 on the limitation of the use of the term "astræoid" in this volume.

6. Porites Brazil 2. (*P. Braziliensis secunda.*)

[Parahybo do Norte, and Candeias Reef, Pernambuco, colls. Branner and Hartt;
U.S. Nat. Museum.]

Syn. *Porites branneri* Rathbun, Proc. U.S. Nat. Museum, x. (1887) p. 355, pl. xix. fig. 2.

Description.—The corallum is usually closely encrusting, with convex surface generally smooth.

* As this name was already applied to a *Porites* from the Red Sea by Forskål, Rehberg suggested that the Brazilian form should be called *Porites verrillii* (Abh. Nat. Wiss. Verein Hamburg, xii. part 1 (1892) p. 48).

The calicles are small, 0.75 to 1 mm., very uniform in size and appearance on the different specimens, moderately deep, except at the edges where they may be entirely superficial. The walls consist of a single stout irregular thread, only faintly zigzag, and with a slightly serrated edge, the processes being echinulate or smooth. The septa vary greatly in thickness and size; they project from the angles of the zigzag walls as short processes with very jagged or echinulate tips. Deep down they unite into a tangle, so loose that the base of the calicle seems as if it remained open. From this tangle a varying number of conspicuous pali arise, in deep calicles half way up the walls, in shallow ones to the surface.

The author of the original description found this coral to be quite distinct from the Brazilian form described by Verrill under the name of *Porites solida* (see last heading), and in this Dr. Vaughan agrees,* therein adding one to the very limited number of species, which, following Dr. Gregory, he allows to the West Indian *Porites*.†

The original figure shows the coral to be, in its structure, quite characteristic of the Atlantic and West Indian *Porites*, but not one of our astræoid group (see p. 142).

Group III.—WEST INDIAN ISLANDS PROPER.

[Exc. The Bahamas, for which see p. 76.]

7. *Porites Curaçoa* 1. (*P. Curaçœ prima*.) (Pl. XVII, fig. 3.)

Syn. *Corallium poris stellatis*, . . . Seba, Thes. (1758) pl. cix. fig. 11.

Description.—The corallum rises into a loose, open and irregular tangle of stems and branchlets, 9 cm. high and 14 cm. across. The forkings are at very irregular distances apart, sometimes as much as 3 cm., at others under 2 cm. This and the fact that the angle of forking at the terminals is larger than a right angle (though this lessens with the growth and thickening of the prongs) cause the stock to be wide, open and straggling. The longer nodes between the forkings vary greatly in thickness,‡ quite irregularly, some less than 1 cm., others, even high up in the stock, may be as much as 1.5 or even 2 cm. thick. These differences appear to be due to the fact that the forking produces prongs of different sizes and thicknesses. The stems are smooth and nearly round, and the prongs are blunt and round-topped. The living layer extends right to the edges of the explanate base.

The calicles are said to have been densely crowded, mostly round, but sometimes rhomboidal, and distinctly sunk (*poris stellatis*). The walls appeared somewhat swollen.

The colour was greyish with a tinge of yellow.

* Bull. U.S. Fish Commission, ii. (1901) p. 317.

† See the Historical section, p. 11.

‡ See Morphological section, p. 17.

If we are justified in assuming that this figure of Seba's is a good representation of the specimen, and that should go almost without saying, considering the known accuracy of his illustrations of other objects, we have in this coral a method of growth which deserves attention. It is difficult to say exactly what was the form of the explanate base from which the stems seem to have started, almost as if they were out-growths of its edges. Unfortunately, Dr. Wayland Vaughan was unable to find any form at Curaçoa which at all closely resembled it. It is true that he found a branching *Porites*, but with a growth-form so entirely different that, following the principles here laid down, we must consider it as a different coral. For the description of Dr. Vaughan's coral, see *P. Curaçoa* 2. In growth-form it shows the very opposite extreme to Seba's coral, viz. a close clustering, while the forking of the older form is such as to make close clustering impossible. As noted by Dr. Vaughan, branching forms more nearly like that of Seba's coral occur in the Florida reefs. In this Catalogue we have been able to record a few instances of this straggling type (*P. Barbados* 3, Pl. IX., fig. 5; *P. Antigua* 3, Pl. X., fig. 7; *P. Belice* 1, Pl. IX., fig. 1); and one from the Florida reefs (No. 5), see Pl. XI., fig. 2, probably part of the same collection as that referred to by Dr. Vaughan. Yet none of these closely resemble Seba's coral except in the one fact that the forking is at a wide angle and occurs at variable distances along the stems, and this growth-habit scatters the branches far and wide into an irregular open tangle.

8. *Porites Curaçoa* 2. (*P. Curaçœ secunda*.)

[Curaçoa, coll. Wayland Vaughan; Washington.]

Syn. *Porites porites* Vaughan, Bulletin U.S. Fish Commission, ii. (1901) p. 314, pl. xxviii.

Description.—The corallum, rising as a single gradually thickening stem, divides into a cluster of wavy branches of varying thickness, by repeated but irregular forking, and at various angles. The closeness of the cluster is due to the bending inwards of the prongs so as to grow as nearly vertical as possible. The stems in a stock 13 cm. high and 16 cm. broad may vary from 1 to 2 cm. thick; they are smooth, round and sinuous, with "knee-bends,"* and aborted prongs. The living layer extends from 3 to 6 cm. deep.

The calicles are shallow, about 1.5 mm. in diameter. The walls near the growing points show a zigzag wall-thread which later thickens as the septa and the rest of the calicle skeleton thicken. It then seems possible to trace (1) a ring of wall granules upon the continuous wall, (2) an inner ring of short septal granules, sometimes joined to and sometimes distinct from the wall, and (3) a clear ring of conspicuous pali, visible to the naked eye as a central boss in the calicle. These pali vary in size and are mostly 5 in number, with a central tubercle, which deeper down is occasionally seen to be united with the pali by the radial strands of a columellar tangle. Groups of calicles occur without any columellar tubercle.

The above description is based upon Dr. Vaughan's excellent photographs of this coral and upon his descriptive text. The growth-form is specially interesting, and belongs to the

* For an explanation of this term, see p. 18.

same group as *P. Porto Rico 3*, *P. West Indies x. 18, 19* and *20*, only it is not so compact, the forking being at slightly larger angles.

The sinuous stems forming the cluster bend up more slowly and with a more open curve; the bends are thus more conspicuous, and the swelling of the stems is much more gradual, and is chiefly to be seen in the fact that the original stem supporting the whole stock is under 1 cm. thick, while some of the top stems are nearer 1.5 cm. The small base from which the stock rises is interesting, cf. *P. Barbados 10*, and the observation thereon.

The fact cannot be overlooked that this is called by Dr. Vaughan *Porites porites*, as if it were the type of the ideal species of branching forms in the West Indies, that is, the type of which all the others are but *formæ*, *forma clavaria*, see p. 63, *forma furcata*, see p. 64, *forma divaricata*, p. 62. As I have already shown at length in the Introduction, there is no justification for this in the history and still less in the morphology of the group. In growth-form, this coral shows a transition between a simpler type of growth with regular dichotomous branching and straight prongs and the type in which the prongs all bend upwards and inwards to form a close cluster of sinuous stems gradually thickening as they rise, as in Dr. Vaughan's own *forma clavaria*, see p. 63.

There is no trace of resemblance between this growth-form and that of Seba's coral, the figure of which is given on Pl. XVII., fig. 3. The two show quite opposite specialisations, the latter has the prongs flung, as it were, outwards in all directions, the very reverse being the case in this coral.

9. *Porites Curaçoa 3*. (*P. Curaçœ tertia*.) (Pl. IX. fig. 6.)

[Paris.*]

Description.—The corallum seems to rise on a short thick stem, 1.25 cm. in diameter, which soon forks into an irregular candelabra-like cluster of short, thick, upcurving branches, the tops of which fork again irregularly into short, round or flat-topped terminals. These may be as thick as the original stem of the stock. The living layer extends 5 cm. deep.

The calicles are large, 1.5 mm. in diameter, angular and everywhere sunk; at the tips they are deep. The walls are sharp and distinct, with a fine wall-thread, often zigzag. The septa are well developed, thick, slightly and irregularly echinulate; they descend as lamellate plates with deep interseptal loculi; here and there in the base of the calicle they can be seen joining the pali. These latter are tall, stout, smooth rods, 5 to 6 in number, but not conspicuous to the naked eye. The columellar tangle is obscure, but the central tubercle is very small and flattened. The general aspect of the calicles to the naked eye is not unlike that characteristic of the astræoid group (see p. 142); in this fact the coral is remarkable among branching forms.

The colour of the unbleached coral is a reddish buff.

This form is of interest, because it shows another branching *Porites* from Curaçoa, quite different from either Seba's or Dr. Vaughan's specimens, see *P. Curaçoa 1* and *2*. The growth-

* This specimen is labelled "J. Bavea, près de Curaçoa." I presume that the first words refer to the collector's name, as I can find no name "Bavea" on any of the available maps or charts of Curaçoa.

form has some resemblance to that of *P. West Indies* x 14, which, however, was still young. It is otherwise unique.

The boldness of the calicles is also a feature of interest.

We have then clearly three different types of *Porites* from Curaçoa alone, which cannot be easily brought into the species scheme mentioned in the Introduction, p. 10.

It is not at all likely that this list exhausts the *Porites* fauna near Curaçoa. Fossils occur in the young Quaternary strata of this and of the neighbouring island Arube. These represent the remains of both branching and encrusting or massive forms.*

10. *Porites* Trinidad 1. (*P. Trinitatis prima*.) (Pl. I. figs. 5a, 5b.)

[Savannah Grande (Eocene †), from the coll. Mus. Pract. Geol. ; British Museum.]

Description.—The fossil shows that the corallum was massive, built up continuously by long, straight trabeculae, very thick and joined by thick, short, horizontal elements. The junctions of the horizontal and vertical elements are swollen like rows of large rounded beads, which run straight along the trabeculae, but are arranged in more or less wavy lines along the horizontal elements. These beaded trabeculae are so thick that only three go to the millimetre.

The calicles, only seen in section, are about 1.25 mm. in diameter and show an irregular wall thread of thick, smooth, skeletal matter with either stout, smooth septa or rounded granules, according to the position of the section. A confused central tangle, quite irregular, consisting of but a few strands can be made out, with no clear traces either of pali or of columellar tubercle.

This fossil is of great interest. The great thickness of the skeletal elements is, as we have seen (cf. p. 13), one of the characteristics of the West Indian *Porites*. Here this character seems to have been exaggerated, perhaps by secondary alteration during fossilisation, although the symmetry of the whole seems to preclude the idea of much change of that kind. The fact that it was a massive form leads us naturally to associate it hypothetically with the astræoid type (p. 142) of glomerate forms occurring in the West Indies. This suggestion finds confirmation in the absence of all traces of pali in the sections. It is possible, therefore, dimly to reconstruct the surface aspect of the calicles, with their deep, open fossæ with short, nearly uniform septa, only fusing deep down with a columellar tangle.

A study of the mass shows that great numbers of organisms were incorporated in it as it grew in thickness, and further that the skeletal elements were not seldom hollowed out

* Vaughan, Sammlungen des Geologischen Reichs-Museum in Leiden, ser. ii. bd. ii. (1901) heft 1.

† Mr. Spencer (Quart. Journ. Geol. Soc., lviii. (1902) p. 357), while quoting Dr. Guppy and Prof. Gregory as claiming the Naparima beds as Eocene formations, thinks them to have been somewhat earlier.

by a boring alga. The clearness with which these hollowed parts of the skeleton can still be seen is a further argument against the suggestion that the fossil has been secondarily altered.

α.

Geol. Dept. R. 9816.

Other forms recorded from Trinidad are: a fossil from St. Croix, said by Duncan * to be synonymous with *Porites Collegniana* = (*Goniopora Turin* 1 †), and a recent *astræoides* (that is, massive) form, not described, apparently because calling it "*Astroïdes*" was thought to be sufficient!

11. *Porites Barbados* 1. (*P. Barbatae prima*.)

[Barbados, coll. Wilkes Expedition, 1838-1842.]

Syn. *Porites flexuosa* Dana, Zooph. (1848) p. 554, pl. liii. fig. 6.

Description.—The corallum forms short tufts of flexuous branches, divaricate, and swollen at the tips, which are very blunt or sub-truncate, or at times sub-flabellate. The branches are from 1.2 to 1.6 cm. thick; when flattened at the tips they may be 2.5 cm. broad. The living layer is 6 cm. deep.

The calicles are large, about 1.5 mm. in diameter, shallow, with flattened floors. The septa are obtuse and (?) project one-third of the way across the calicle.

The corallum is very porous and with spongy apices.

There is, in the National Collection, only one branching form from Barbados, which produces small, branching tufts with divaricate forkings. But the measurements show it to be a much smaller form with smaller calicles than this coral of Dana's. The spongy tip and consequent reticular axis is characteristic of all branching *Porites*, but seems to be especially developed in the Barbados forms (cf. e.g. *P. Barbados* 5). This character is not shown in Dana's figure, which merely represents a single slightly curved terminal. The remark that it is not unlike *P. clavaria* is too vague to be of any use. The specimen is referred to by Dr. Rathbun in his "Catalogue of *Porites*." ‡

12. *Porites Barbados* 2. (*P. Barbatae secunda*.) (Pl. I. fig. 8; Pl. XV. fig. 5.)

[Barbados, coll. Gregory; British Museum.]

Syn. ? *Porites furcata* Dana (*non* Lamarck), Zooph. (1848) p. 555.

Description.—The corallum forms tufts of thin, somewhat tortuous, divaricate branches, varying from 8 to 12 mm. thick, round or compressed. The forking is quite irregular: one prong frequently aborts, with the result that most of the branches show sudden, almost angular bends. Stems frequently appear to divide into three branchlets. The tips of the terminals were either round or greatly flattened. The living layer is about 3 cm. deep.

* Quart. Journ. Geol. Soc., xxiv. (1867) p. 25.

† Vol. IV. p. 117, of this Catalogue.

‡ Proc. U.S. National Museum, x. (1887) p. 354.

The calicles are small, about 1 mm., as slight depressions in the surface. The slightly zigzag wall-ridges of the younger regions become faint and ill-defined between the depressions, and, in the older parts, consist of somewhat straggling wall-flakes occasionally disguised by rising filaments. The septa are thick and short, whether projecting from the wall-ridge or from the edges of the flakes. Their tips are swollen and finely frosted or echinulate. The successive tiers do not form very straight vertical rows, so that the interseptal loculi are inconspicuous. Five frosted granules like the tips of the septa represent the pali, which form a small ring surrounding a very minute central tubercle.

The section shows a very loose, somewhat extensive, axial, streaming layer surrounded by a thin, nearly solid, cortex layer.

This character of the section seems common to the Barbados forms, both recent and fossil; see the following descriptions. The blunt tips of terminals frequently consist entirely of loose, flaky, filamentous reticulum.

A comparison of this form with the description given by Dana, of a small, branching *Porites* from Barbados, which he called *P. furcata*,* shows them to be very similar. Until, therefore, the types can be closely compared, they may be provisionally regarded as the same.

Some of the fragments in spite of being bleached show traces of the blue colour noticed on p. 21. Dana's specimens were dark brown in colour.

a. Small tuft in seven fragments.

Zool. Dept. 99. 6. 26. 12.

13. *Porites Barbados* 3. (*P. Barbatae tertia.*) (Pl. I. fig. 9; Pl. IX. fig. 5.)

[Barbados, coll. Gregory; British Museum]

Description.—The corallum is ramose, with stems 2 cm. and more thick and often slightly flattened. It branches irregularly at all angles and at varying distances. The terminals are short, round, and from 1 to 1.4 cm. thick. The living layer may be 13 cm. deep and bordered below by an epithecal film.

The calicles are about 1.5 mm. in diameter, ill-defined, and but slightly depressed as irregular breaks in the granulated surface. The walls are all flat-topped and very variable, sometimes thick, at others incomplete; the component elements are confused and difficult to make out. There is frequently a smooth, delicate, very zigzag wall-thread, occasionally reticular, and this is associated in one way or another, mostly very irregularly, with a ring of septal granules which appear to belong to the wall, thus greatly thickening it. These septal granules are sometimes distinct, sometimes joined to the wall, and sometimes joined to the pali, which latter are generally conspicuous but irregular, the four lateral principles being very large, and frosted like the septal granules; the directive pali are variously developed, and

* On this specimen, see Rathbun, Proc. U.S. National Museum, x. (1887) p. 354.

there is either a small tubercle or deep, open fossa. The septal formula is, however, seldom complete or symmetrical.

Large double calicles seem to be common. They are shallow and have a conspicuous, nearly solid, columellar tangle, filling up the greater part of their bases.

The colour of the unbleached stock is yellowish-brown. The axial strand is an open, delicate, lamellate reticulum, round which the cortical layer is rather dense but mostly conspicuously trabecular.

The chief characteristics of this coral are its very variable wall-texture, its peculiar granular surface, the large frosted granules being too coarse to give the surface a velvet-like appearance. They all appear separate though crowded, with here and there a smooth, delicate, zigzag, sometimes even reticulate wall-thread developed between them. In certain regions the granules thicken and become flaky, and then the calicles are hardly recognisable, and the surface appears dense though rough and porous. The co-ordination of these surface granules with the conspicuous trabeculae seen in the section is obvious.

These recent specimens are further interesting, because, although the central reticular axis is fairly thick, it is not by any means so pronounced as it is in many of the Pleistocene fragments described below (cf. *P. Barbados* 5). In these latter the thin, cortical layer is nearly solid and quite distinct from the developed trabecular layer seen in the above.

The bleached fragment of this coral shows the hollowing out of its skeletal elements by a boring alga.

- a. Three large stems in a box with many } Zool. Dept. 99. 6. 26. 10 (part).
smaller fragments.

14. *Porites Barbados* 4. (*P. Barbata quarta*.) (Pl. II. fig. 1; Pl. IX. fig. 7.)

[Barbados, coll. Gregory; British Museum.]

Description.—The corallum rises into rounded, slightly flexuous stems, often flattened, rather more than 1 cm. thick. The forking is at small angles, with a tendency to curve outwards from one another, and at short distances apart (1.5 cm.). The two prongs are often of unequal sizes, the smaller becoming aborted and remaining behind, the larger and thicker growing and again dividing. The stock expands partly by the outward curving of the branchlets. The living layer is 5–6 cm. deep.

The calicles are very ill defined, from 1 to 1.5 mm. in diameter, slightly depressed as irregular breaks in the surface. The wall is here a slight zigzag thread, there it consists of elegant, continuous flakes with rounded pores; it is mostly very incomplete, variable in thickness and texture, and without definite arrangement of its component elements. The septa are thin and irregular, but as the walls become more solid and flaky, they may appear as thick, irregular ridges running over the walls, but without symmetry and only occasionally projecting far into the shallow calicular depressions. Immediately below this irregular margin, the skeletal elements become so flaky as almost to suggest a film spreading through a dying

coral. Minute pali, up to 5, appear in a circle too straggling to be conspicuous to the naked eye. A columellar tubercle or a central pit can be made out in the less rapidly solidifying calicles.

In transverse sections the axial strand is an open, lamellate reticulum; the cortical layer is almost solid.

This coral, though about the same size, is quite different in the manner of its branching and in the texture of its calicles from *P. Barbados* 2. The forking, though irregular in the sizes of the prongs, is yet not so irregular as that of the latter coral.

There is only one stem (*a*) which, when gathered, was alive; with it are two other specimens which appear to belong to it, although doubts may be legitimately expressed:—

b. Is a corroded forking stem with rather more conspicuous calicles than *a*, but with traces of a very similar section to the stems and somewhat similar forking. This is only provisionally placed here.

c. Represents a corroded, encrusted mass, showing the section of a stem very similar to that of *a*, and on it two young colonies, one a minute disk in its epithecal saucer, and the other considerably older and rising into two forking peaks about 1 cm. high. The calicles are a little smaller, and the walls rise as irregularly trabecular ridges. What little experience we have of early growth stages in the Stony Corals seems to indicate that the calicles of the very young colonies are smaller than those of the adults, and moreover show other differences. It is clear, however, that we can only provisionally class this specimen here.

a, b.

Zool. Dept. 99. 6. 26. 11.

c.

Zool. Dept. 99. 6. 26. 10 (part).

15. *Porites Barbados* 5. (*P. Barbatæ quinta*.)

[Barbados (Pleistocene), coll. Franks; British Museum.]

Under this heading we provisionally group a number of fossilised and semi-fossilised fragments of branching *Porites*, which for the purposes of description may be divided as follows:—

A number of beach-worn, gravel-coloured specimens, of various sizes, but all showing in the sections a remarkable contrast between an immense, openly reticular, axial strand, and a comparatively thin, dense cortical layer. Many of the worn fragments consist solely of this axial reticulum.

a. The largest specimens.

Geol. Dept. R. 2557.

b. The only specimen showing remains of probably }
young calicles near a spongy terminal; with a }
microscopic slide.

„ R. 2193.

*c*₁. A great number of smaller much worn fragments.

„ R. 2559 (part).

*c*₂. Three fragments selected from the above with a great deal of chalky white colour about them, not much worn and showing traces of the calicles. The skeletal elements

are, however, too corroded to show reliable details. The cross section no longer shows the same striking proportions between axial and cortical regions, the former being here small and central, the larger part of the section being the dense periphery. One seems to be part of the remains of a thin branched specimen 1 cm. thick, with forking at about 90°, the other two of a coral the stems of which were 1.5 cm. thick with forkings of 120°.

*c*₁.

Geol. Dept. R. 2559 (part).

*c*₂. This may perhaps be a separate fragment of the same coral as *c*₁. It shows the calicles a little more distinctly with short, stout, wedge-shaped septa abutting irregularly upon a solid wall on which a fine wavy thread can be traced and large rounded pali related to the fusing septa in the typical manner.

*c*₃.

Geol. Dept. R. 2534.

d. Deserves special mention. It is not only more truly fossilised but shows further differences. The calicles, though apparently corroded and thus with their skeletal elements thickened, are still conspicuous, and the section shows a more uniform, open, but stout network across the whole fracture. The forkings are sharply rectangular, with the internodal stems straight and of nearly uniform thickness (1.5 cm.). The surface layer with its calicles seem to consist of nearly uniformly thick, smooth, skeletal elements arranged as a network of short threads so grouped as to show calicle areas with stout, continuous, roughly zigzag walls, and the beginnings of radially arranged septa. The majority of the latter are quite short, one or two, however, joining the pali which are an irregular group of smooth, round granules confused with other skeletal (columellar) elements. The calicles were about 1.20 mm. in diameter.

These details hardly represent the original living condition of the coral, as it is almost certain that the finer points of the skeletal elements have been corroded off.

d.

Geol. Dept. R. 2536.

e. This is a solid block of limestone from Castle Grant, Barbados, with one or more fragments of a branching *Porites* embedded in it. The sections seem to have been about 1 cm. in diameter, and show a rather thin, coarse axial reticulum, surrounded by a thick, dense, cortical layer of very stout, irregular skeleton, that is, without any marked differentiation into radial (or trabecular) and concentric elements.

Geol. Dept. R. 9817.

16. *Porites Barbados* 6. (*P. Barbata sexta*.) (Pl. IX. fig. 4.)

[Barbados (Pleistocene), coll. Franks; British Museum.]

Description.—The corallum rises with long, slender, cylindrical and slightly wavy stems, which give off lateral spurs nearly at right angles and at various distances apart. The stems

may be as much as 1.5 cm. thick, and the spurs 1.2. Pieces of stem occur 9 cm. in length without any spur, and the tapering tip above the topmost mammillate-like spur may be 5.5 cm. long and 0.5 cm. thick at the rounded apex. Depth of living layer appears to have been great, over 12 cm.

The calicles were 1.5 mm. in diameter, shallow funnel-shaped. The walls, somewhat obscured, appear as if they were sharp, obtuse-angled ridges between the calicles and show skeletal elements varying greatly in thickness, here swollen and thickened, there very thin. The septa are also very variable in texture; they are conspicuous, some thin, others thick, or broad and flaky, each one varying along its own length; laterally they are notched rather than echinulate. The pali appear as large rounded knobs.

The section shows rather a thick, axial layer of somewhat close streaming reticulum of stout threads, passing very gradually into a fairly regular radial and concentric system of stout elements, yet with conspicuous oblong pores, so that the whole section is open reticulum without any part solidified.

The growth-form of this fossil *Porites* is so far unique. The fragments might easily have been taken at first sight for those of *Madrepora*, but fortunately the calicles, though mostly corroded, can here and there be made out, and leave no doubt but that it is a true *Porites*. Its spur formation can be easily deduced from the typical forking. One prong stands out as a spur and aborts while the other carries the stem continuously onwards with hardly a curve.

The nearest *Porites* to this as to its growth-form would probably be *P. Java Sea 2* (Vol. V. p. 189, Pl. XXVIII. fig. 8, Pl. XXIX. fig. 2); the sharp thin tapering stems belong to both, but unfortunately we do not know what the complete stock of this coral is like. Certainly neither the branching of *P. Java Sea 2* nor its calicles show any resemblance to those of this coral.

a. Five fragments.

Geol. Dept. R. 2551.

17. *Porites Barbados 7.* (*P. Barbatæ septima.*) (Pl. IX. fig. 2, left hand figure.)

[Barbados (Pleistocene), coll. Franks; British Museum.]

Description.—The corallum rises in erect stems, fairly uniform in thickness, and either forking at small angles (30°) or rising zigzag owing to incipient but abortive forking, one prong remaining as a knee-bend or short process. These forkings or attempts at forking are at fairly regular distances, 2 cm. apart. The depth of the living layer was at least 5 cm.

The calicles have all been worn down but are plainly visible in section where the surface is not abraded down to the axial streaming reticulum. They are slightly over 1 mm. in diameter. The skeletal elements forming a rather close reticulum, the walls, septa and columellar tangle, varying very much in thickness, here swollen, there thin, but the calicle symmetry is traceable here and there, and even the number of the pali, six, can be made out.

The section shows a very large axial strand, loose, open, and almost as much filamentous

as it is flaky. This passes gradually into a cortical layer, which is also irregularly reticular and only dimly shows a tendency of the elements to bend out radially towards the surface in wavy lines. No distinctly trabecular or concentric elements appear.

In addition to the chief fragment above described, which allows so much of the original character of the coral to be seen, are two fragments worn down beyond recognition except that the section resembles the section of *a*, and the surface is not unlike the surface of the basal tip of *a*, which had also been worn down quite thin. This coral is quite distinct from the last, although in its thin, tall growth-form it seems to lead on to it. Cf. also the next form.

- a.* With a longitudinal section and a microscopic slide. Geol. Dept. R. 2194.
b. c. Two worn fragments probably of the same. Geol. Dept. R. 2551 and 2552.

18. **Porites Barbados 8.** (*P. Barbatae octava.*) (Pl. IX. fig. 2, right hand figure, and 3.)

[Low level reef, near Bridgetown, coll. Bishop Mitchinson; British Museum.]

Description.—The corallum forms tufts of small, smooth branches varying greatly in thickness not only among themselves (some being round and only 9 mm., and others slightly flattened and as much as 15 mm. in longest diameter) but also along their lengths owing to slight fusiform thickenings alternating with gradual constrictions. The forkings are at small angles, but apparently irregularly, the branches occasionally fusing together.

The calicles are very small, under 1 mm., and for some 3 cm. below the tips quite ill-defined, that is without any walls visible at the surface, the interseptal loculi of adjacent calicles running continuously into one another. This character seems to pass away owing to the columellar tangle sinking below the level of the wall region, which then forms a ridge, along which a thread may sometimes run, at others the septal striæ rise above the flaky texture of the wall, and between these striæ the interseptal loculi communicate freely.

In addition to the specimen *a*, which distantly resembles *P. Barbados 4*, at least in growth-form, there is a long wavy fragment, 6 cm. long and 1 cm. thick, which may be of the same kind. I would suggest that it may have been stimulated to extra growth in length by a worm twining its calcareous tube up one side of it. The actual tips of both have been broken, but it would appear as if the two had raced upwards to try and top one another. The stem shows great irregularity in thickness as if its normal growth had been interfered with, and its living surface to have been prejudicially affected by the worm at different levels. It shows no trace of having attempted to fork. That it is the same coral appears likely from the similarity in general character of the calicles. The section has a smaller axial strand, but otherwise agrees. It is in this fragment that we can trace the gradual appearance of the raised wall-ridges, the small nodulated and echinulated septa and the pali together forming a sort of loose open mosaic of granules over the surface.

- a.* Adhering to a bivalve, see Pl. IX. fig. 3, right hand figure.
b. With coiled worm-tube, see Pl. IX. fig. 2, right hand figure. } Geol. Dept. R. 2544.

In addition to the above is another complete branch, labelled simply "Barbados," which may have been of the same kind. It is much bent, and covered with mammillate processes. But the character which suggests affinity most strongly is the fact that the calicles have no clearly defined walls near the tips. This, coupled with the general similarity in size and growth-form, as far as the latter can be made out in *a*, justifies us in provisionally classing them together, in spite of such differences as the slightly greater size of the calicles and the comparative openness of the skeletal network in this specimen.

c. Pl. IX. fig. 3, left-hand figure.

Geol. Dept. R. 2489.

19. *Porites Barbados* 9. (*P. Barbatae nona*.)

[High level reef, Castle Grant, coll. Jukes Browne; and summit of Mount Misery, 1053 feet, St. Thomas Parish, coll. Colonel Fielden (Pleistocene); British Museum.]

Under this heading three massive fragments, which seem to be of the same kind, are included. The coral seems to have spread as thick flat cakes with very wavy surface, indeed mounting into a number of domelike uprisings (specimens *a* and *b*) with deep, narrow, round-bottomed depressions between (specimen *a*). These domes were of different sizes and heights, large (up to 2.5 cm.) and small. This is a specialisation of the surface not elsewhere known among the astræoid *Porites*.

The coral (specimen *a*), during fossilisation, has decayed in such a manner as to appear to have been built up of tier upon tier of thin layers, which, in the section, can be seen to curve up and down over the domes and into the valleys. These are probably lines of weakness due to the hollowing out of some of the thick horizontal layers of the skeleton by boring algæ.

In the sections (specimens *a* and *b*) the elements, vertical and horizontal, are both conspicuous, not so thick, perhaps, as in the fossil massive form *P. Trinidad* 1 (see Pl. I. fig. 5, *b*), and certainly not so conspicuously beaded. One remarkable point is the presence of very large smooth rods (in specimen *a*) running always parallel with, and looking as if they were, very large trabeculæ, but unlike trabeculæ in being attached only at a few points to the rest of the skeleton; these appear at the surface as small, open rings. I take them to represent the remains of worm-tubes, which retain the same thickness through the coral. Appearances suggest that these were numerous in the deep valleys, but not always present on the domelike uprisings. In this connection we may note also that the elements of the dome-like elevations are not so thick and pronounced, the skeleton having altogether a lighter and more irregularly reticular texture than in the depressions.

Specimen *c*, which seems to be from the same locality as specimen *a*, shows these thick trabeculæ or worm-tubes rather more closely joined to the skeleton, but still individualised in a way which seems to distinguish them from trabeculæ, unless they might be some very special development of the central columellar tubercle; but if that were the case, some radial symmetry should be seen round them, which is hardly ever the case. Indeed they are at times found crowded together.

The chief morphological interest in this coral lies in its sharing with the Trinidad specimen the thick trabeculae, unlike any of the known recent massive *Porites*.

a. Cf. *c.*

Geol. Dept. R. 2476.

b.

Geol. Dept. R. 1950.

c. Cf. *a.*

Geol. Dept. R. 2505.

20. *Porites Barbados* 10. (*P. Barbatae decima.*)

[Barbados (Pleistocene); British Museum.]

Description.—This is a small, roughly egg-shaped mass, 3 cm. long and 2 cm. at its thicker end. It appears to have been a complete stock. It is corroded, but not much worn, and what looks like the outline of a colony, creeping down its swollen top and encrusting its sides, can still be made out round the base of the stock, while again the mass which it appears to encrust shows signs of having been an earlier stage of the same *Porites*. Can this be the starting-point of a branching form? It looks as if it might be, and if so, it is of considerable interest because of the very small size of its base, above which the first stem swells into an ovate mass. Many branching forms early fall over and new colonies start from their sides and thus build up tangles, the new stock always growing on the overturned old. It might well be that some do actually begin to rise almost at once, that is without the formation of any basal disk. On this subject see further, Table III. *E. d.*, p. 136, and, on the falling over of coral stocks, the last paragraph of p. 133.

The calicles are almost too corroded to give reliable details, but they were at least 1.5 mm. in diameter and distinctly depressed with conspicuous walls.

a.

Geol. Dept. R. 1282.

21. *Porites Guadalupe* 1. (*P. Guadalupeensis prima.*)

[Guadalupe, coll. Lesueur; ?]

Syn. Porites divaricata Lesueur, Mém. du Mus. Paris, vi. (1820) p. 288.

Description.—The corallum forms very delicate, thin branched stocks, some 5 cm. high and more. The branches fork at wide angles, so that the whole is open and spread out, the lateral branchlets even pointing downwards all round. The tips are flattened before forking. The living colony is confined to the uppermost portions of the stock.

The only other details of this coral to be gathered from the original description are that, though the living colony is confined to the upper portions of the branches, it nevertheless descends lower down than in (*P. recta* =) *P. St. Bartholomew* 1, see p. 53, and again that in the divergent and oblique arrangement of the branches it contrasts strongly with the close grouping of the branches of that same coral.

It is greatly to be desired that search should be made for new specimens of this coral in

this same region. Such a search might lead to important results and show us whether changes are gradually taking place in the *Porites* fauna of the Islands. I make the suggestion because, though other forms have been since gathered at Guadalupe, this one has not reappeared, and further, because the fossil-forms of these islands do not yet show any close resemblance with known living forms. The material for working this out is, I know, far too limited to justify more than a doubt.

On the suggestion made by Dr. Vaughan that this should be a type of growth-form, one of his "formæ" of the single branching species *Porites porites*, see remarks p. 16. See also below, *P. Porto Rico 2*.

22. *Porites* Guadalupe 2. (*P. Guadalupeensis secunda*.)

[Guadalupe, coll. Lesueur; ?]

Syn. *Porites flabelliformis* Lesueur, Mém. du Mus., vi. (1820) p. 289.

Description.—The corallum is branching; the branches are divergent, opposite and horizontally arranged on a slightly flattened stem; the branchlets flatten and fork at the tips. The living layer extends to the base.

The calicles are "small, contiguous, spiny, and pentagonal."

In addition to the above description, the height, apparently of the polyps but really of the stock, is given as 2.5 to 5 cm. The peculiarity of this *Porites* is its flattening tips and perhaps the horizontal disposition of the branches round a central stem, although this is not very clear from the description. Until fresh specimens are discovered from this same locality, we shall never know exactly what this coral was like.

There is an old specimen in the Paris Museum (No. Z 182j) with somewhat flabellate tips to the branches, the branches themselves being both slightly flattened and divergent. Though it is labelled, "*P. clavaria*, coll. Michelin," it is just possible that it may have been one of Lesueur's larger specimens. It is more fully described below, see p. 87, *P. West Indies x. 3*, Pl. XIV. fig. 2.

23. *Porites* Guadalupe 3. (*P. Guadalupeensis tertia*.)

[Guadalupe, coll. Lesueur; ?]

Syn. *Porites astrozoides* Lesueur, Mém. du Mus., vi. (1820) p. 287, pl. xvi. figs. 15, a, b, c.

This is described and figured as an encrusting form with gibbous expansions. The calicles are small, close together and circular or subpentagonal.

In growing it spreads over foreign bodies which come in its way. It is thin, here and there rising into irregular mounds, perhaps due to the bodies it has covered over.

When the polyps are expanded, the colony has, according to the author, the appearance of a small field covered with flowers. The general colour is a beautiful sulphur-yellow with

a slight greenish tint. The tentacles are red, though yellow at the tips, and with a black spot at their extremities, suggestive of an aperture.

Though this is a thin expanding form, it has always been regarded as one of the more massive *astræoides* of Authors (see Table III. B and remarks.)

24. *Porites* Guadalupe 4. (*P. Guadalupe* *quarta*.) (Pl. XI. fig. 5.)

[Guadalupe, coll. Duchassaing; Paris Museum.]

Description.—The corallum rises as a compact cluster of erect, stout, slightly sinuous and gradually thickening lobes of different thicknesses, which slightly flatten and divide at small angles; only the swollen rounded tips of the lobes are alive for about 2 cm.

The calicles are about 1.5 mm. in diameter. At the tips they open flush with the surface in a very delicate lamellate reticulum, the septa being thin wavy lamellæ joining a columellar tangle level with the surface. Below this tip the walls rise as thin, regularly zigzag membranes above the septa and columellar tangle. Below this again the trabecular elements of the walls rise high as tall bristles and flattened spikes, while the intervening membranous portions are developed only intermittently. Stray spikes and plates represent the septa. The surface is thus coarsely hirsute. At varying depths a straggling reticulum can be seen from which a few tall pali arise, sometimes in a compact cluster with the columellar tubercle, at others with a deep, open, central fossa. Before dying down and being covered over by the epithecal film, the calicles tend to flatten down again and the columellar tangle to rise with a central rosette of 4 to 5 granules as pali and a central tubercle.

The colour of the unbleached coral, which is about 13 cm. high, is a reddish buff. The bristly surface sometimes shows through the epithecal film.

This description is based upon a specimen in the Paris Museum (No. 196a) labelled "*Porites valida*, M. Duchassaing—Guadalupe." In the supplement to "Les Coralliaires des Antilles," p. 94, Pl. X. fig. 13, this author in conjunction with Michelotti, described and figured a specimen from St. Thomas (occurring also at Tortola), which they called *Porites valida* (see p. 56). A comparison of their description of that coral with the above shows them to be quite different corals. The extraordinarily bristly surface shown in this coral by the upgrowth of the trabeculæ of the walls is too remarkable to be overlooked. It is true that the St. Thomas coral is said to have denticulate walls, but that word is quite inadequate to describe the condition above noted. Further there is said to be no columella in the specimen from St. Thomas; there certainly is in this specimen, though here and there the fossa is open.

This growth-form is of interest and may be compared with that of others, c.f. e.g. *P. Curaçoa* 2; see also Table III. p. 136. It represents the type with gradually thickening, usually slightly sinuous stems, which, of all others, deserves the name "*clavaria*," if that name is to be used in its descriptive sense, see the Historical Sketch, p. 3.

25. *Porites* Guadalupe 5. (*P. Guadalupeensis quinta.*) (Pl. XVI. fig. 6).

[Guadalupe; Paris Museum.]

Description.—The corallum rises as a stout wavy stem, which tends to fork rapidly at distances of about 1 cm. apart. The outer of the two short prongs is frequently aborted, leaving a "knee bend" (see p. 31, footnote). It is these bends which give the waviness to the stem. The shortness of the prongs keeps the mass from branching out in any direction far from the chief axial stem. The living layer is about 8 cm. deep; the dead parts being covered with epithecal film.

The calicles are small, from 0.75 to 1 mm., and deep. The walls are thin and zigzag, and descend vertically all round into the calicle. Short, thick septa begin to appear irregularly right from the top edge of the wall, but the radial symmetry of the rest of the internal septal skeleton is obscured. The interseptal loculi are represented by deep open holes, without traces of radial symmetry. The pali are large, but irregular in position and number.

The section showed an open reticulum.

The description is based upon my notes of Specimen No. Z 182a of the collection of West Indian *Porites* in the Paris Museum. It was labelled *P. clavaria*, as from the "Antilles (Guadaloup)." Though called *P. clavaria*, this specimen was obviously not the same, either in growth-form or in size of calicles, as Lamarck's type specimen, for a description of which see below, p. 81.

Again, it shows quite a regular method of forking along its whole length, and yet can hardly be said to be either of the form *clavaria* or *furcata*, using these terms to express a difference, somewhat vague it is true, due chiefly to the distance apart at which forking takes place. Among all the many branching forms from the West Indies I have seen none which remind me of this. It is quite different also from other branching forms from the same locality, not only in growth-form but also in calicle formation.

It is quite clear then from these examples (see also observations to *P. Guadalupe 4*) that such vague semi-descriptive terms as *clavaria* and *furcata* are quite inadequate for the burden which has been put upon them (see Historical Sketch, p. 3). A comparison of the growth-forms must be undertaken systematically; for a preliminary attempt, see Table III., p. 130.

26. *Porites* Guadalupe 6. (*P. Guadalupeensis sexta.*) (Pl. II. figs. 2, 3.)

[Guadalupe, coll. Duchassaing; Turin Museum.]

Syn. *Porites Guadalupeensis* Duchassaing and Michelotti, Les Cor. des Antilles (1860) p. 83.

Neoporites Guadalupeensis Duchassaing and Michelotti, Les Cor. des Antilles Supplement (1864) p. 99.

Description.—The corallum is encrusting with surface raised into rounded lobes. The calicles are deep, with smooth, wedge-shaped septa.

This is one of the encrusting group usually called collectively *P. astræoides* and regarded as a single species. See remarks upon this group in the Introduction, p. 15, and Table III.

Through the kindness of Count Peracca we can gather some further details of calicle structure of this specimen from the two magnifications shown on Pl. II. figs. 2 and 3, which show two extreme types of calicles, found on Duchassaing's type specimen, which is preserved in the Turin Museum. While the walls shown in fig. 2 are those generally regarded as typical of "*P. astræoides*" and occur very frequently, here and there the walls proliferate into a thick, jagged, flaky network. There are reasons for believing that this alteration may be due to the somewhat inconvenient juxtaposition of other organisms. We certainly learn from the specimens of *P. Bahamas 1*, that this kind of wall-proliferation may be so produced. See Pl. IV. figs. 3 and 4, which are alterations of fig. 2 due to such interference.

Duchassaing's name for this coral was given by Quelch in the 'Challenger' report to an encrusting form from Cape Verde Islands, see p. 26.

27. *Porites Antigua 1*. (*P. Antiguæ prima*.) (Pl. II. fig. 4; Pl. X. fig. 1.)

[Packam Sound Reef, coll. Gregory; British Museum.]

Description.—The corallum rises on a central stem and divides dichotomously to form a compact cluster of very short stems about 1.5 cm. thick, and forking about every 1.5 cm. apart; the terminals are short, thick, rounded knobs. The living layer is at least 3 cm. deep.

The calicles are 1.5 mm. in diameter, shallow and open, but with a low, sharply raised wall, which makes them look polygonal. The walls show a thin, smooth, zigzag thread somewhat obscured by the diverging septa which branch off each side; as the skeleton thickens, they are completely lost; seen sideways they appear here and there ragged and somewhat lamellate. The smooth septa seem to swell rapidly into frosted or echinulate knobs; as they project from the wall they are all of different lengths, one or two perhaps uniting with their corresponding pali high up, the others only lower down, though their pali may rise up freely above them. The pali and the septal knobs show signs of expanding laterally into horizontal flakes a short way down, and incipient fringes appear round them. But in spite of this the reticulum of the intracalicular skeleton remains open enough to see deep down into the depths. The pali (5) rise from a long, scattered, columellar tangle not very sharply circumscribed by the ring of interseptal loculi, which are all irregular in outline and arrangement.

The section shows a rather open network with conspicuous radiating trabeculæ and well-developed concentric elements.

The specimen shows a regular growth which had forked four or five times, and had attained a height of some 8 cm. when it was overturned, and a new growth had spread over one side, and from it mammillate processes, some 1.5 cm. high, had arisen. We have then to gather the real characters of this *Porites* from the dead overturned stock. And this requires some care, because some of its tips had evidently survived the overthrow, and continued to

grow and bend upwards into the vertical. From the characters of the branching of this stock, we can distinguish it from either of the other two known Antiguan branching forms. Comparisons of the calicles, and of the sections of the stems, show them all to be distinct.

It is possible that some of the mammillate processes rising up sharply from the dead surface of the basal stem may be fresh growths and illustrate the typical origin of this branching form. Cf. the observation under *P. Barbados* 10, p. 42.

a.

Zool. Dept. 99. 6. 26. 4.

28. **Porites Antigua 2.** (*P. Antiguæ secunda.*) (Pl. II. fig. 5; Pl. X. fig. 4.)

[Antigua, coll. Gregory; British Museum.]

Description.—The corallum rises into low, bushy clusters, the stems under 1.5 cm. thick, forking dichotomously at about 2 cm. apart, the angle being open, but less than a right angle. The terminals are 1 cm. thick and slightly tapering. They appear at times to have been bent in on one side, owing probably to crowding, and then they may fork irregularly. The living layer, being 3 cm. deep and less, is consequently broken up among the different branches.

The calicles are small, 1 mm., shallow but rather sharply sunk, and subcircular. The walls are pronounced, not flat-topped but built of the rapidly thickening smooth tips of trabeculae which sideways show as a pronounced denticulation. From above they are seen in a zigzag arrangement, sometimes running transversely as septal ridges, at others irregularly or in two rows representing the tops of the septa of adjacent calicles; usually very compact and solid. The radial symmetry of the calicles is confined to these wall-granules. In younger calicles a wall-thread, from which short septa project, is often present; this quite disappears lower down.

Within the calicle the pali rise from what appears to be a coarse, nearly solid, columellar tangle. They rise as stout rods, five, sometimes six, with a columellar tubercle or a central fossa.

The section is very dense.

There are two specimens of this coral, which fit together to make a good sized stock standing 10 cm. high. It is very unlike any of the other branching forms from Antigua. Its chief characteristic seems to be that the generic characters merely appear in the arrangement of the top edges of the walls, the tops of the septa and pali. Immediately below these, the elements thicken into a very coarse reticulum, which seems rapidly to solidify. The radial symmetry, even of the interseptal loculi, is very faint, but one of these is frequently abnormally developed, being as large as the central fossa which is sometimes visible. Seen laterally, the wall appears coarse, low and irregularly denticulate.

a. With a bleached and corroded fragment.

Zool. Dept. 99. 6. 26. 5.

29. *Porites Antigua* 3. (*P. Antiquæ tertia.*) (Pl. II. fig. 6; Pl. X. fig. 7.)

[Antigua, coll. Gregory; British Museum.]

Description.—The corallum develops tangles of tall, stout, branching stems, of nearly uniform thickness, 1.5 to 2 cm. thick, forking at wide angles which, however, gradually change into rounded curves, as the prongs bend up into the vertical. The terminals are thick and mostly swollen and flat-topped at the tips. The branches of adjacent stems fuse together. The crowding of the stems seems to be the cause of the forking being at irregular distances; single prongs may grow straight up for 5 cm. with only slight indications of knee-bends (= abortive attempts to fork, see p. 18) before beginning really to fork. The living layer seems to be about 7 cm. deep.

The calicles are large, slightly under 2 mm., nearly superficial. The walls are low and thick, consisting of an irregularly zigzag arrangement of the meeting of the septa of adjacent calicles without any differentiation of a distinct wall-thread; the thickness of the thread varies according as the septa are thin or thick and flaky (on under surfaces and near the basal parts of the living layer). The septa throughout are mere rough projections from the walls, of various lengths and showing no conspicuous radial symmetry. The pali are large, rough granules, not very prominently raised and very irregularly joining with the septa. The inter-septal loculi are not conspicuous, being irregular, straggling breaks into the interior with here and there one large one. The columellar tangle is fairly compact and for the most part carries a large central tubercle. All the granules are roughened, and, as the skeleton thickens, tend to spread into flakes.

The section shows the periphery for about 2 mm. as a fairly close network of radial trabeculae and stout concentric rings. Within this cortical layer it becomes nearly solid.

The colour of the dried corallum is a dark sepia.

This coral differs in growth-form and in size and character of the calicles from any of the other known branching forms from Antigua. There is an approach to whorl-formation of the branches where the forking has been disturbed by overcrowding, such as is also seen in a part of the large type specimen of Lamarek's *Porites furcata* in *Paris* (see below, p. 82). But the calicles of the two corals are not alike according to the descriptions.

a.

Zool. Dept. 99. 6. 26. 2.

b. A stem which seems to have fallen over.

Zool. Dept. 99. 6. 26. 3.

30. *Porites Antigua* 4. (*P. Antiquæ quarta.*) (Pl. II. fig. 7; Pl. XVII. fig. 4.)

[Antigua, coll. Gregory; British Museum.]

Description.—The corallum is explanate and massive with thick, free, expanding edges showing only slight drooping. Successive growths appear to pile up on one another with

their edges, here free, there creeping. The central regions rise up into a few tall peaks with steep sides and joined together like those of a mountain range diminishing in size till near the edges, where the surface becomes quite smooth.

The calicles are large and conspicuous, and nearly uniform over the whole surface, about 1.5 mm. from wall-ridge to wall-ridge. The walls are everywhere thick and reticular, and differ chiefly in being here rounded and there with a sharp median ridge. The wall-network seen sideways is light and open, but seen from above looks close and solid. The septa project as smooth, short threads, of uniform size and thickness throughout, and along their lengths individually. They show a perfect radial symmetry except where here and there two appear as if they would fuse in the typical manner. The columellar tangle appears as a smooth, compact or solid, circular floor in the fossa, surrounded by a symmetrical ring of deep, rounded, interseptal loculi.

The colour of the unbleached coral is a deep brown.

This is one of the massive forms usually called "*astræoides*," but it is impossible to ignore the difference in its calicles from those of the usual type shown in Pl. II. fig. 2. A comparison between this and such forms as the two described below and figured as *P. West Indies* x 27 and 28, shows clearly that the old "*astræoides*" is by no means a homogeneous group, see Introduction, p. 15, and for the limitation here adopted of the term "*astræoid*," see Table IV. p. 142.

a.

Zool. Dept. 99. 6. 26. 6.

31. **Porites Barbuda 1.** (*P. Barbudæ prima*.) (Pl. II. fig. 8; Pl. X. fig. 3.)

[Barbuda, coll. Gregory; British Museum.]

Description.—The corallum is branching, rising apparently from a stout, nodular base, from which short thick processes project in different directions and either remain as mamillate stumps or flatten and begin to fork. If they succeed in forking, one prong in each case usually remains aborted, sometimes at so early a stage of its growth as to make only a knee-bend in the stem. The forkings, or attempts at forking, seem to take place at about 6 to 8 mm. apart. The growing branches are about 1.5 cm. thick. The living layer is about 5 cm. deep.

The calicles, shallow and subcircular, vary from 1.5 to 2 mm. in diameter. The walls are thin but without definite order of the skeletal elements and therefore very irregular. This is partly due to the irregular thicknesses of the skeletal elements, which are everywhere smooth and glistening. They are here thin and filamentous, there broad and flaky, elsewhere again as stout granules; in all parts these skeletal elements run into one another as if melting together without any sharp angles or regular pattern. The zigzag of the wall-thread appears chiefly in the arrangement of the smooth, swollen granules, which represent the points where the septa abut upon the walls. The septa project very variably and irregularly from the walls, but continually meet the columellar tangle, though the formula is somewhat obscure, the septa being frequently bent about in such a way as to fill the calicle up with an open

reticulum, thus disguising the radial symmetry. The pali are sometimes regular, but mostly very irregular as small knobs; here and there they are replaced by a stout, prominent, skeletal ring, which, owing to the fact that it may surround a deep, open fossa, is very conspicuous even to the naked eye. These columellar rings seem to be most frequent where the axial reticulum, which comes to the surface at growing tips, is passing into adult calicle formation. Small central tubercles appear where the columellar tangle has no such open fossa.

The sections of the basal stump and of the branches show the comparatively thin axial reticulum surrounded by dense coral perforated by but a few canals. The skeleton is coloured a faint blue-grey.

The bluish colour of this coral is interesting. As is well known it is characteristic of the alcyonarian *Heliopora*, but according to my experience it is rare in the Stony Corals. I have found one other *Porites*, see *P. West Indies* x. 24, p. 101, from this region, and I recall one from the Indo-Pacific area, *P. Great Barrier Reef* 37, Vol. V. p. 140, which, curiously enough, has a growth-form very commonly seen in *Heliopora*. Besides these, a few Madreporae are known showing various shades of blue, and there is the well-known figure of *Turbinaria cinerascens* of Ellis and Solander. I am not aware that any investigations have been made as to the cause of this variation in the colour of the Stony Corals which on being bleached are typically snow white.

The locality of the other specimen referred to (see *Porites West Indies* x. 24) is not recorded. This is most unfortunate, for although its calicles and its skeletal texture are entirely different, yet it has one startling peculiarity in common, namely the conspicuous columellar or palic rings surrounding deep fossæ. In both corals these minute rings are visible to the naked eye, but in the form above described they occur only in clusters, especially near the growing tips; in the other form they are almost universal (see further, Table III. E, *a*, and E, *b*).

a.

Zool. Dept. 99. 6. 26. 8.

32. *Porites Barbuda* 2. (*P. Barbudæ secunda*.) (Pl. II. fig. 9; Pl. X. fig. 6.)

[Barbuda, coll. Gregory; British Museum.]

Description.—The corallum is small and the forking is so close and irregular that the cluster appears to have been low and contorted. In the single specimen the main stem, 9 mm. in diameter, swells suddenly into a knob 1.5 mm. in diameter. From this swelling, in addition to two blunt projections (? aborted attempts to fork), two constricted stems carry up the coral. These commence at once to swell again and to fork, and so on. The terminals are flattened, from 5 to 7 mm. thick and 12 mm. broad, and point in all directions. The extent of the living layer is unknown: at least 3 cm.

The calicles are small, 1 mm. in diameter, shallow and for the most part as irregular breaks in a ragged surface of flaky reticulum; here and there, e.g. on swelling surfaces, they are deeper and more regular. The walls seem everywhere composed of horizontal, flaky reticulum, the meshes showing a tendency to be neat, circular pores; they vary in thickness, here and

there thinning away to narrow single bands, but where the calicles are best developed they are stout. The top surface of the walls may be composed of flakes, either smooth or else with irregular faintly frosted granules and threads, coarse and thick, scattered upon them. The septa are irregular projections from the edges of the bands or flakes; they are broad and their usually widened ends are slightly echinulate; the interseptal loculi are cut back to varying depths into the flakes irregularly or smooth and rounded. The pali are usually close, irregular rings of 5 large frosted granules, one at times very large, and here and there joined to the tips of septa. They do not rise high in the calicle and mostly surround a minute, open fossa, but the calicle is nowhere deep, being early filled up with skeletal reticulum.

The section shows a close axial network of fine skeletal matter, surrounded by a very dense, almost solid layer.

This coral cannot well be brought into line with the great mass of the branching West Indian forms, inasmuch as its forking seems to be very irregular. It is, however, obvious that when forking takes place very rapidly, say at distances less than 1 cm. apart, great irregularities would be expected owing to the excessive crowding which would result.

It is interesting to note that this small branching form shows a similar flaky reticulum with round pores as does the only explanate form known from this locality (No. 3). We call attention to this fact, although we can make no use of it. There is no trace of it in the blue coral from this locality, so that it is not a character common to all the Barbuda *Porites*.

a.

Zool. Dept. 99. 6. 26. 9.

33. *Porites Barbuda* 3. (*P. Barbudæ tertia*.) (Pl. III. fig. 1; Pl. XVII. fig. 5.)

[Barbuda, coll. Gregory; British Museum.]

Description.—The corallum is explanate, with edges drooping and even bending under. The surface is irregular, having somewhat smooth facets separated by bluntly angular ridges. The colony loosely encrusts dead corals.

The calicles are small, 1 mm. and under, circular and shallow, but somewhat sharply sunk as if punctured into the surface. The walls are generally thick and consist apparently entirely of continuous flat layers of smooth, horizontal, flaky skeletal elements perforated with small circular holes. No traces of trabecular elements appear at all. The septa are projections from the edges of these horizontal layers, sometimes short and thin or somewhat longer and knobbed. Neat rings of deep, round, interseptal loculi, surround a large columellar floor to the calicle. This is sometimes solid, at others rises into an irregular reticulum which unites with that of the wall, so that the only trace of radial symmetry is seen in the circular rings of small, round, interseptal loculi. Parts of the surface become in this way continuously but raggedly reticular, with only irregular breaks representing the calicles.

This coral should be compared with *P. Anguilla* 2. The two appear somewhat alike, and

under the old fashioned method would have been certainly classed together as a species, one being made the type and the other a variety, though which should be which would have rested upon the arbitrary choice of the worker. This method is, to me, wholly unscientific and consequently indefensible. That the two are closely related no one can deny; they not only belong to the same genus, but they have special characters in common. Both are small encrusting colonies; both seem to begin as ragged, flaky layers of skeletal network, with very irregular calicles opening in it. But then they diverge; in one, the skeletal network persists as so many horizontal layers running into one another and perforated by neat, round holes, with no apparently trabecular formation; in the other, trabecular and horizontal elements become more equally developed, and the network is more uniformly filamentous. In this latter, owing to the development of trabeculæ, the walls of the calicles rise into surging ridges, and the whole aspect of the surface changes. These then are, as far as we can yet see, the chief morphological differences. What we want to know is their meaning and explanation. If we write down that one is a species, and the other a variety of it, we are guessing at the very thing we wish to find out. That is not the only objection to such methods, for we should have not only guessing, but, worse still, guessing in terms which we cannot define, and thus enveloping the facts in a cloud instead of stating them as simply and as clearly as possible for the use of the students who come after us.

a.

1906. 1. 1. 21.

34. *Porites* Nevis Island 1. (*P. Nevis prima*.)

[Nevis Island,* coll. Lesueur; ?]

Syn. *Porites clavaria* Lesueur, Mém. du Mus. vi. (1820) p. 289, pl. xvii. fig. 17.

The original description is as follows:—

“*P. dichotomo-ramulosa*; ramulis crassis, sub clavatis, obsolete compressis; stellis latis, planulatis, contiguis, superficialibus.”

The tentacles of the animals are said to be whitish, but quite white at the tips and arranged round a reddish (burnt sienna) disk, which rises into a short cone; the mouth is bordered with white. The protruded animal was not seen to rise higher than about half the diameter of the calicle. Its sides were ribbed or furrowed. The corallum rises 15 cm. high, but in spite of its size it is very fragile. With its crowded, intertwined branches it covers great areas.

Lesueur says that it is not the same as Ellis and Solander's coral,† because the living layer is confined to the tops of the stems, whereas in the *Madrepora Porites* figured by Ellis and Solander it extends over the whole corallum. The fragility of the coral is not a known character of Lamarck's type of *clavaria*, see p. 81. Lesueur's figure shows quite an unusual growth-form; I have never seen a *Porites* like it. And it is worth noting that its possession

* In the little harbour which faces “St. Eustache.”

† Zoophytes (1786) p. 172, pl. xlvii. fig. 1.

of a long, cylindrical, basal stem, which shows signs of having attempted, in vain, to fork, suggests that the coral grew in sand, and was consequently only alive at its tips, that is, as high above the shifting medium as possible. Very rapid upward growth would explain its fragility. Further, the fact that his *P. recta* from an adjoining locality has the same long dead stalks, although by its branching it is a different form, supports this reference of the cause to the nature of the environment: indeed, a sandy bottom is mentioned by Lesueur for that form. These corals ought to be re-discovered, and submitted to a fresh, comparative study, for very little can be ascertained as to the real character of the ultimate forking from the two figures given by Lesueur, excellent as they are. All that we can there gather is that they differ greatly in their initial phases. If the rule holds that the principle of growth in these branching forms is a continual repetition of the initial stages, it is clear that these two forms would make very different adult stocks. See further the observation under *P. St. Bartholomew 1*, below.

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From this island Lesueur gathered specimens closely resembling the form he called *P. recta*, which occurred at St. Bartholomew.

35. *Porites St. Bartholomew 1.* (*P. Bartolomæi prima.*)

[St. Bartholomew, * coll. Lesueur; ?]

Syn. *Porites recta* Lesueur, Mém. du Mus. vi. (1820) p. 288, pl. xvii. fig. 16.

Description.—The corallum rises on a long, dead, basal stem, some 5 to 6 cm. high, slightly compressed. The tip forks at very wide angles, the terminals being oblique and rounded. The living layer is confined to the tips of the stems.

The calicles are small, deep, with spiny or denticulate septa.

The polyp is of a reddish colour, with white lines running up the body between the tentacles. A white, polygonal, twelve-sided line also runs between the different polyps, apparently following the line of the skeletal walls: perhaps the walls themselves show through. The tips of the tentacles are white, with a semicircle of deep burnt sienna.

The coral lives in calm water, and is easily detached from the sandy bottom out of which it seems to grow.

This *Porites*, like *P. Nevis Island 1*, seems adapted to grow out of sand. Note the observations under *P. Nevis Island 1*, and the confinement of the living layer to the summits of the stems. It forks only after it has got some height above the sand. All its growth energies are probably concentrated in the endeavour to rise above the shifting particles which are always injurious to the delicate polyps. Once fairly out of the reach of the sand the colony can grow out more freely and begin, however irregularly, to fork in the way characteristic of so many of the West Indian *Porites*. Lesueur's figures show neither in this case nor in that of *P. Nevis Island 1* more than the earliest beginnings of forking.

Fresh descriptions of these corals are needed with a closer comparison of the calicles. It

* Lesueur adds also St. Christopher.

would be worth investigating whether these *Porites* are permanently adapted to this life in sand, or whether they are mere specimens of some other form with a characteristic method of growth altered by having to live on a sandy floor.

Duchassaing and Michelotti* suggested that this coral was the same as Lamarck's *P. furcata*; but see p. 82.

36. *Porites Anguilla* 1. (*P. Anguillæ prima*.) (Pl. III. fig. 2; Pl. X. fig. 5.)

[Anguilla, coll. Gregory; British Museum.]

Description.—The corallum is branching and apparently very small. The stems are about 8 mm. thick, and either round or slightly flattened. They appear to fork at distances of 8 to 10 mm. apart. The forking is irregular, one prong often aborted and the other (? accidentally) somewhat twisted. The flattened ends are often with only one lateral out-growth, making the tips irregularly hammer-headed. The living layer is 2 cm. deep.

The calicles are mostly very minute, 1 mm. the largest, and much less; they show great irregularities and variations of structure. The walls are raised, and are stout and irregular, consisting of thick wall, or septal granules, crowded too closely to show much trace of any zigzag arrangement of the concentric elements. In the larger calicles, the complete, septal formula can be made out; the septa meet in coarse nodes which rise as pali. In the smaller calicles, their numbers may be greatly reduced, and the ring of pali may be united with the walls by quite irregular septal strands. The interseptal loculi are clear and deep in the younger calicles, and the whole skeleton is more open, its elements being thinner, but in the older and shallower calicles the elements are thick and coarse, and the interseptal loculi much shallower and less marked. In these latter, the columellar tangle is frequently a solid plate, elsewhere a deep open fossa occurs in the place of the central tubercle.

In the section, the skeletal elements are seen to be very irregularly arranged, and very thick and coarse especially round the periphery. The axial, streaming reticulum is stout, but of a somewhat finer texture.

Two small fragments were examined and figured: one, the larger, appeared as if it had been standing erect when collected, the other (*a*) as if it had been loose, and lying on its side, from which side two finger-like up-growths have started. These up-growths may perhaps represent early stages in the growth of the colony, and illustrate its habitual method of rising into branching forms. The larger of these finger-shaped processes is 12 mm. long, and 6 mm. thickest diameter, the smaller 8 mm. and 4 mm. Both these up-growths consist entirely of a close reticulum such as that which formed the axis of the larger specimen (since accidentally mislaid), and the tips of its forkings.

The calicles are difficult to describe owing to their small sizes, and the irregularities in the thickness of the skeletal elements, which are generally smooth. In this latter fact, as well as in the sizes of the calicles, and also in the growth-form, this coral differs conspicuously from *P. Porto Rico* 2, which is another of the known minute West Indian forms.

* *Mém. sur les Cor. des Antilles*, Suppl. (1864) p. 95.

This coral ought to be easy to identify, when the island is again visited for a study of its corals.

a.

Zool. Dept. 99. 6. 26. 7.

37. **Porites Anguilla 2.** (*P. Anguillæ secunda.*) (Pl. III. fig. 3.)

[Anguilla, coll. Gregory; British Museum.]

Description.—The corallum forms small, convex cushions, apparently built up of thin, explanate layers, with very thin edges, which may be hindered from reaching the substratum all round by attached foreign organisms. An oval specimen, 3.5 cm. long by 2.5 cm. broad, attains a thickness of 1.5 cm. The surface is roughed by irregularities in the thicknesses and heights of the walls.

The calicles are circular, 1 mm. in diameter, sharply sunk, but not very deep, and at unequal distances apart. The walls are thick, of coarse, thick, skeletal reticulum, so as to be nearly solid. The septa are short, thick, regular, but showing slight differences between primary and secondary cycles. They show a tendency to be knobbed with occasional fusions into pairs. The columellar tangle is usually a large solid plate, with knobbed surface, without indications of regular pali, but generally of a massive central tubercle.

The skeletal texture of the very young colony of this coral, seems to be a loose, open, irregular, streaming network, which only becomes trabecular as it thickens; even then the trabeculæ are not conspicuous or regular.

Compare with this coral a somewhat similar kind, *Porites Barbuda 3*, and the observations there made.

a.

Zool. Dept. 1906. 1. 1. 22.

38. **Porites Santa Cruz 1.** (*P. Sanctæ Crucis prima.*)

[Santa Cruz Island, coll. Duchassaing; Turin Museum (?) *]

Syn. *Neoporites Michelini* Duchassaing and Michelotti, Mém. sur les Cor. des Antilles, Suppl. (1864) p. 98, pl. x. figs. 9, 10.

Description.—The corallum is convex and encrusting.

The calicles are very small, about 1 mm., superficial, with sunken centre. The septa are long, thin, very echinulate, and without prominent fusions. There are from 1 to 3 crisp pali.

* Dr. Wayland Vaughan was unable to find the type of this coral in the Turin Museum (see 'Stony Corals of the Porto Rican Waters,' U.S. Fish Com. Bull. (1901) ii. p. 317), and he placed it in the synonymy of *P. astræoides*.

This specimen, judging from the description and figure, is not one of the massive "*Porites astravoides*" of the West Indies. It is represented as a small, irregularly disk-like patch, with slightly crumpled surface, and appears to belong to one of the most primitive forms, viz. a small encrusting disk, see Table III. p. 130. It shows some resemblance to a form encrusting a large *Mussa*, and described below among the *Porites* from unknown localities (x. 9); see p. 117.

Its long echinulate septa, with only faint traces of the palic formula, might belong either to a West Indian or to an Indo-Pacific form.

39. *Porites* St. Thomas 1. (*P. Sancti-Thomæ prima*.)

[St. Thomas and Tortola, coll. Duchassaing; ? Turin Museum.]

Syn. *Porites valida* Duch. and Mich., Mém. sur les Cor. des Antilles, Suppl. (1864) p. 94, pl. x. fig. 13.

Description.—The corallum forms single, stout, raised stems, 20 to 30 cm. high and 3 to 4 and more cm. thick, with swollen, slightly flattened tips which fork at wide angles. The living layer seems to cover the whole stem from top to base.

The calicles are sunk, 1.5 mm. in diameter, with thin denticulate walls, and smooth septa, with 3 to 4 sharp, smooth, cylindrical pali. There is no columella.

This brief description is taken from the original text. But above, on p. 44, under the heading *Porites Guadalupe 4*, we have described a very different coral preserved in the Paris Museum, which was also named *Porites valida*, apparently by Duchassaing himself. A comparison of the descriptions and figures shows that they differ greatly, both in growth (cf. Pl. XI. fig. 5) and in the characters of the calicles. *Porites Guadalupe 4* has a surface remarkable for the erect trabeculae standing up like coarse bristles. There is no mention of this character—and it is too remarkable to have escaped notice—in the text of the author's mémoire written in conjunction with Michelotti. I do not see on what grounds the two can be united under one name.

There appears to be a slight discrepancy between the author's original figure and his text. The measurements of the stems given in the latter are 3 to 4 and more cm. thick and 20 to 30 cm. ("8–12 pollicaris") high. The figure, said to be of natural size, shows a specimen about 2 cm. thick and about 6 cm. high.

The mistake is due to the addition of the words "*Grandeur naturelle*," for, that the specimen was really large, we may gather from the name "*valida*."

This *Porites* is quite unique so far as the records go, quite as unique as are those described and figured by Lesueur (*P. Nevis Island* and *P. St. Bartholomew I*). The lumping of them all into one or two species is simply the negation of classification.

40. *Porites* St. Thomas 2. (*P. Sancti-Thomæ secunda*.) (Pl. XI. fig. 1.)

[St. Thomas, coll. M. Duchassaing; Paris Museum.]

Description.—The corallum rises into branching cylindrical stems, forming tufts. The forkings are at rather wide angles, with thick round terminals (1·3 cm. across). The living layer extends 7 cm.

The calicles are large, 2 mm., superficial except at the tips, where the walls are slightly raised. The walls are thin, sharp, zigzag threads, but in older parts the skeleton thickens rapidly and the thin thread appears as if resting on a broad zigzag flake (see Appendix, p. 143). The septa are conspicuous, sometimes continuous, sometimes as radial rows of 2 to 3 granules from which the pali are hardly distinguishable. Seen from above the septa are laterally very echinulate, the echinulæ obscuring the long interseptal loculi, which are further affected by the development of an echinulate columellar tangle which appears to fill the calicles. The pali (6) are chiefly distinguishable in the younger deeper calicles. In the older calicles they are somewhat confused with the granules upon the septa.

The section is an open flaky reticulum.

This description is based upon notes made in the Paris Museum, where the specimen is preserved as Z 182b. The remarkable echinulation of the skeleton leads me to think that this must have been one of Duchassaing's type specimens of his *P. clavaria*, because he placed it under a heading "*Septis pallulisque hirtis*." If so, we gather from the description that the living coral was of a rust colour, sometimes of a more or less deep wine red. The tentacles are of the same colour, but get paler and paler towards their tips, which are hardly coloured at all.

Though the branching is not unlike that of Lamarck's *P. clavaria*, there is no echinulation of the skeleton in that coral, hence, according to Duchassaing's own system, based upon the presence or absence of echinulæ, the two are specifically distinct.

41. *Porites* St. Thomas 3. (*P. Sancti-Thomæ tertia*.) (Pl. III. fig. 4; Pl. XI. fig. 4.)

[St. Thomas, coll. Duchassaing; Paris and Turin Museums.]

Syn. ? *Porites Solanderi* Duchassaing and Michelotti, Mém. sur les Cor. des Antilles (1860) p. 83; and Suppl. (1864) p. 95.

Description.—The corallum forms compact clusters of short, thick, almost pear-shaped lobes with large flat tops, so that the whole stock is squat and low.

The calicles, apparently about 1·5 mm., are flush with the surface. The walls are delicately lamellate, often incomplete, and show traces of the tendency to break up into conspicuous denticulations. They are beset with delicate echinulations. The septa are also echinulate, as are also the pali, which are visibly the inner ends of the septa, and are 5 to 6

in number. The columellar tangle is always visible, but the central tubercle, which is also echinulate, is sometimes absent.

This description is based upon notes made in the Paris Museum on a specimen Z 194a, and labelled "*Porites Solanderi*, St. Thomas, M. Duchassaing." It seems to agree fairly with the very brief description given in the original text, and also with the specimen in the Turin Museum, regarded as the type of *P. Solanderi*, D. and M., a magnified photograph of which was kindly prepared for this Catalogue by Count Peracca, see Pl. III. fig. 4. The coral was apparently given this name by M. Duchassaing, because of its supposed resemblance to that figured in Ellis and Solander's *Zoophytes*, pl. xlvii. fig. 1. This synonymy, suggested in the original work, is not repeated in the supplement. I find in my notes that the specimen has certain striking resemblances with *P. Guadalupe* 3, only the trabeculae do not stand up like tall bristles. The resemblance suggested is, I think, delusive, and rests upon the shape of the branches and the ragged denticulate walls. They may, however, be related more nearly than simply as members of the same genus.

It should be remembered that the figures of the calicles here given are from the Turin specimen, while the growth-form is that of the Paris specimen, which we have assumed to be of the same kind.

42. *Porites* St. Thomas 4. (*P. Sancti-Thomæ quarta*.) (Pl. III. fig. 5.)

[St. Thomas, coll. Duchassaing and Michelotti; Turin.]

Syn. *Porites plumieri* Duch. and Mich., Mém. sur les Cor. des Antilles Suppl. (1864) p. 96, pl. x. fig. 14.

Description.—The corallum rises as round, slightly swelling stems, which fork dichotomously, the prongs tending to bend in towards the vertical in slight curves. Of each pair of prongs that furthest from the axis seems oftenest to abort. This causes the stock to rise rapidly in height, with here and there a few lateral branches of different sizes. When clusters of these stems rise side by side, their branches seem to fuse freely. The living layer seems to extend indefinitely downwards over the stock.

Calicles everywhere superficial, slightly over 1 mm. in diameter but very irregular in size, sub-circular or polygonal, with sides of very unequal lengths. The walls are thin, incomplete, and show only faint traces of any zigzag arrangement of the connecting lines which vary greatly in thickness, here thin and there thick. The septa project from the walls very irregularly, both as to thickness and length; the irregularities being doubtless due to their being very perforate. In every calicle one or more may be seen united with one or more of the pali; but for these unions with the septa, the pali rise to the surface mostly as separate granules, although other unions both with one another and with a small central tubercle can be traced deeper down. The five principals are always present, and for the most part they surround a deep central fossa. The septa and granules, either septal or paliform, are mostly frosted or finely echinulate.

This description is based chiefly upon the figure given by the authors, and upon the

magnified photograph of the calicles kindly taken from the type specimen in the Turin Museum by Count Peracca for the purpose of this volume. Part of this photograph is reproduced on Pl. III. fig. 5, and it will be seen that the calicles agree well with their original Latin description—*Parietibus modo tenuibus modo evanidis, inde calyces sæpissime confusi*—as far as this goes. The specimen was placed into that division of the group described by the authors as *septis pallulisque hirtis, calycibus sæpe columella destitutis atque omnino superficialibus*.

The fusiform swellings of the stems recalls *P. Florida* 2. I do not remember having seen it in any other form. The original description says that the specimen was a foot in height, but the figure ("*Grand. Nat.*") is only about 10 cm. high. But as in the case of their *P. valida*, the words "*Grand. Nat.*" were probably added by mistake; see above, p. 56.

43. **Porites St. Thomas 5.** (*P. Sancti-Thomæ quinta*.) (Pl. III. figs. 6 and 7a;
Pl. XVII. fig. 6.)

[St. Thomas, coll. Duchassaing and H.M.S. 'Challenger'; Turin Museum
and British Museum.]

Syn. *Porites superficialis* Duchassaing and Michelotti, Mém. sur les Cor. des Antilles (1860) p. 83.

Neoporites superficialis, Suppl. (1864) p. 99.

? *Porites astræoides* Quelch, Chall. Rep., xvi. (1886) p. 182.

Description.—The corallum is encrusting and thick. It spreads out over foreign bodies.

The calicles are superficial, the fossæ not very deep. The septa finely toothed (along their internal edges). The pali few, 1 to 3, or almost obsolete.

The polyps are of a sulphur or greenish-yellow, with red disks, and yellowish-green tentacles.

According to the usual method of classification of the West Indian *Porites*, this creeping form should be united with the *Neoporites incerta* of the same authors and from the same locality, and certainly with their *Cosmoporites*, which referred specially to creeping forms. But once more, this lumping of all creeping, encrusting and massive forms into one species, *P. astræoides*, is not classification, but its negation.

There is, however, great probability that the creeping *Porites* described by Quelch in the 'Challenger' Report from this locality is the same. We are not surprised that Quelch called it *P. astræoides*.* As a matter of fact, it is like this coral of Duchassaing's, closely encrusting, and it even envelops the branches of other corals, see Pl. XVII. fig. 6. The surface is raised into great numbers of small excrescences, sufficiently crowded to give no flat surface to be photographed. The unbleached part of the 'Challenger' specimen is a buff colour. If there are any differences between the calicles of the two, they are certainly not easy to see. The varying thickness and textures of the walls, and the different sizes of the calicles, seem to have been the same in both, and in both there is a central tubercle, perhaps a little more con-

* But with this coral in his hand so closely resembling Duchassaing's *P. superficialis*, and even coming from the same locality, it seems strange that he should have applied the name *superficialis* to a specimen from the Cape Verde Islands, see above, p. 27.

spicuous in Duchassaing's coral than in that of the 'Challenger' (cf. Pl. III. fig. 6, which represents the former with fig. 7a, which is taken from the latter).

a.

Zool. Dept. 86. 12. 9. 365.

Under this heading, we may provisionally place the *Neoporites incerta* (Pl. III. fig. 7b) of these same authors and from this same locality. A magnified photograph of the type was kindly sent by Count Peracca, taken in the Turin Museum. The surface was said to be tuberosus or even lobate, therein possibly resembling the 'Challenger' specimen. The polyps had yellowish-green or even green tentacles, and some specimens seemed to the authors to agree with those described by Lesueur as having tentacles brown at the base, yellow above and with a black spot at the tip. Differences in the skeletal textures, however, are apparent, but it is difficult to discover what they are without having the specimens themselves to compare.

44. **Porites St. Thomas 6.** (*P. Sancti-Thomæ sexta.*)

[St. Thomas, coll. Duchassaing; ?]

Syn. *Neoporites subtilis* Duchassaing and Michelotti, Mém sur les Cor. des Antilles, Suppl. (1864) p. 98, pl. x. figs. 7, 8.

Description.—The corallum is placentiform, convex above, concave below, partly encrusting, partly free, supported by epitheca.

The calicles are very small, like small points and seeming to run together. The septa are smooth, sharply serrate down their axial edges, and with 2 or 3 pali just traceable.

The colony is a sulphur colour, with yellowish disk and greenish tentacles.

Turning to the original figures, we see a surface raised into low convex mounds, smooth, of irregular sizes, and separated by narrow concave valleys. The picture of the calicle seems to have been taken from some abnormal double calicle. The coral differs from the *P. St. Thomas 5* in its much smaller calicles and in the running together of the latter, which would signify very thin and incomplete reticular walls.

The name "*subtilis*" signifies some such textural character differentiating it from the more typical astræoid *Porites*. Such a term is quite inapplicable to calicles like those shown, say, in Pl. I. fig. 6, and Pl. II. fig. 5, which are typical of the astræoid group (see Table IV. p. 142).

45. **Porites St. Thomas 7.** (*P. Sancti-Thomæ septima.*)

[St. Thomas, coll. Duchassaing; ?*]

Syn. *Cosmoporites lævigata* Duchassaing and Michelotti, Mém. sur les Cor. des Antilles, Suppl. (1864) p. 99, pl. x. figs. 12, 16.

Description.—The corallum is creeping and encrusting.

The calicles are small, pentagonal, only slightly pitted, with septa, smooth along the

* The type was not found by Count Peracca in the Turin Museum.

edges, denticulate down their axial margins; without pali, and with a porous columellar tangle composed of slightly twisted lamellæ.

The living colony is brown or purplish-brown; the tentacles are sometimes a beautiful green, at others a greenish-white.

This coral again appears to have shown quite definable variations on the ordinary astræoid type, variations which require recording. The name "*lævigata*" refers either to the smoothness of the whole stock or to that of the septa and skeletal elements. This latter smoothness is brought out in the original figure No. 16 (printed on the plate as 12)

The very fact that the authors took this to represent even a new genus, shows that it differed very decidedly from both *P. St. Thomas* 5 and 6. These differences, so emphatically recorded, require to be further investigated, and not ignored as they are by the wholesale lumping of them all together as *P. astræoides*.

For another somewhat remarkable form, the *P. macrocephala* D. and M., which probably comes from this locality, see below, p. 89.

46. **Porites Porto Rico 1.** (*P. Porti-Riconis prima.*) (Pl. XI. fig. 3.)

[Porto Rico, coll. Duchassaing; Paris Museum.]

Description.—The corallum rises in rather tall, close and compact tufts. The branches fork dichotomously, about 1.25 cm. apart, and at angles of about 60°. The prong furthest from the axis of the stock tends usually to bend inwards so as to keep the cluster compact. The stems are somewhat slender, between 1 and 2 cm.; the terminals are thick and blunt, and the living layer is 4 cm. deep.

The calicles are large, 1.75 mm., superficial, as dark spots on a loose, open, granular surface. The wall-threads are excessively thin, mostly wanting. The septa are symmetrical, long, commencing on the wall as remarkable stellate granules, the septa themselves being laterally so echinulate as to appear feathered. The pali rise as similar stellate granules, usually five, but with others occasionally present. The interseptal loculi are symmetrical; the columellar tangle is well developed, and the central tubercle flattened.

This description is based upon my notes on specimen Z 1871 in the Paris Museum, labelled "*Porites furcata*, Porto Rico, M. Duchassaing." The most remarkable feature is the extraordinary development of the echinulation of the skeletal elements. It was quite unique among the Paris specimens, and has no close counterpart in any specimen in the British Museum. As far as I can see, therefore, we have nothing to do with speculations as to whether the specimen is or is not specifically identical with that originally called *P. furcata* (see p. 82). We have to record the *forms* assumed by the genus.

In Duchassaing's and Michelotti's *Mém. sur les Cor. des Antilles*, Suppl. (1864) p. 95, they mention the species *Porites furcata* Lmk., giving Lesueur's *Porites recta* (= *P. St. Bartholomew 1*) as synonym, but it does not appear to refer to any definite specimen. They merely add that *P. furcata* occurs in many of the islands of the Caribbean Sea with many variations of form and coloration.

47. *Porites Porto Rico* 2. (*P. Porti-Riconis secunda*.)

[Off Culebra, Point Mula Lighthouse, 15½ fathoms, coral sand, coll. U.S. Fish Commission, 1898-99; Washington and British Museums.]

Syn. "*Porites porites* forma *divaricata* Lesueur," Vaughan, Bull. U.S. Fish Commission for 1900, (1902), ii. p. 316, pl. ii. figs. 4a, 4b.

Description.—The corallum branches at wide angles, 90° and more. The stem and branches are all very thin and delicate, from 6 mm. to 4 mm., which is the diameter of the ultimate branchlets; these are round-topped and of nearly uniform thickness throughout their lengths. The forking is slow and seems to take place about every 1.4 cm. apart. The stock is thus open. The lower stems are covered with an epithecal film, the living layer being about 2 cm. deep.

The calicles vary somewhat in size, but from mid-wall to mid-wall appear to be about 1.75 mm. across. They are very shallow, but distinctly depressed. The walls are low and consist mainly of a stout, nodulated rather than zigzag thread, though here and there this latter character becomes distinct. The wall-thread is also further distinguished by the fact that it is comparatively smooth. Its septal projections are short and stout, and with very finely echinulate knobs at their tips. The symmetry of the calicles is obscured by the more or less imperfect rows of granules along the edges of the septa. It is best seen in those calicles which are drawn out of shape upwards in the direction of growth. Over the greater part of the surface, the internal skeleton is coarsely granular. The columellar tangle is, as a whole, smooth, nodular, and very solid looking, but from its surface finely echinulate granules arise showing great variety in size and distribution. Sometimes these may be limited to 5 large pali in a ring, although their typical connections with the septa are obscured; at others, the ring of pali may be only just distinguishable by their size and order from among a number of granules, larger or smaller, scattered apparently without order or obvious relation to the typical calicular skeleton. It is possible that some of them may be homologues of the typical septal granules.

The section shows a small, open, filamentous axial reticulum, round which the elements thicken enormously into irregular solid masses, obliterating all traces of any regular lattice-like skeleton.

The designation applied to this form by Dr. Vaughan, given above in the heading, implies that it is the same coral as that recorded from Guadalupe, in 1820, by Lesueur, a description of which is given above, p. 42, and it will there be seen that the data are insufficient to allow us to affirm either that they are or are not identical. Reference to the Table III. will show that branching forms with wide angles of forking are not so rare that they must all be classed together. A comparison of them, indeed, shows that the divaricate forking occurs in many quite different forms.

Some 20 specimens were collected associated with *Oculina diffusa*? var. *Axelia mirabilis*, and *Mæandrina mæandrites*? young.

A small specimen has been kindly presented to this Museum by Dr. Vaughan.

a. In four small fragments.

Zool. Dept. 1906. 1. 1. 1.

48. *Porites Porto Rico* 3. (*P. Porti-Riconis tertia*.)

[Culebra, Ensenada Honda, coll. U.S. Fish Commission; U.S. National Museum, Washington.]

Syn. "*Porites porites* forma *clavaria* Lamarck," Vaughan, Bull. U.S. Fish Commission for 1900, ii. (1902) p. 316, pl. xxiv. and pl. xxxi. fig. 2.

Description.*—The corallum rises as a close cluster of stout, erect stems, without fusions. They are faintly sinuous, and very gradually thicken as they rise, or perhaps we should say, they are of very varying thicknesses, here slightly swollen, there constricted so that their sides are irregularly wavy; and they fork at small angles at about every 2 cm. apart; the prongs bending inwards so as to continue the erect growth. The stems are from 2 to 3.5 cm. thick, the terminals about 2 cm. thick and about 2 cm. long. Only the tips are alive for about 3 cm. deep. Irregular bands of epitheca appear, often bending upwards as films over dying edges.

The calicles are about 2 mm. across, quite superficial, except that in the younger parts the granules representing the septa and pali do not rise as high as those of the wall. The wall is a very irregular zigzag, swelling at the angles into roughened granules, the uniting thread being sometimes thick, sometimes thin, sometimes wanting. The septa show the same characters: the formula is complete, but the connections between the roughened granules—septal and palic—are very irregularly developed. Near the growing tips the granules are all smooth and swollen portions of lamellate plates, the portions of which connecting the granules seldom rising to the surface. The older the calicles are the larger are the granules and the rougher, and the nearer to the surface rise the connecting pieces which grow thicker and gradually rougher, like the granules. The varying sizes of the pali, owing to the irregularity of their roughness somewhat obscures the symmetry of the formula. The usual five principals can be made out, with an occasional, small, dorsal directive and irregular disintegration of the triplet.

Where the surface has been abraded near the top, the smooth, continuous, lamellate elements of the skeleton come to light, showing a well-developed spongy columella. The central tubercle undergoes the same variations in size and appearance as the rest of the granules.

For the account of the types of Lamarck's *Porites clavaria*, as also of his *Porites furcata*,

* The details here given are taken from the excellent photographs given by Dr. Vaughan above cited.

see pp. 81 and 82. Their growth-forms are quite different from this. Indeed, it seems to me that the method of growth shown by this coral illustrates a type of growth-form distinct enough to be used for purposes of grouping according to growth-forms; see for example Introduction, p. 19, also Table III. p. 136.

The differences between the calicles are more subtle and difficult to describe, yet if the description given on p. 81, of the calicles of Lamarck's type specimen, is compared with that given above, it will have to be admitted that they cannot be arbitrarily ignored. That this is a distinct "local form" we can gather from Dr. Vaughan's words "there are no indications in these specimens * of an intergradation with *forma furcata*," that is, with another branching form belonging to the same locality, see below, and p. 11.

49. *Porites* Porto Rico 4. (*P. Porti-Riconis quarta*.)

[Culebra, Ensenada Honda, coll. U.S. Fish Commission, 1898-99; Washington.]

Syn. "*Porites porites* forma *furcata* Lamarck," Vaughan, Bull. U.S. Fish Commission for 1900, ii. (1901) p. 316, pl. xxx. and xxxi. fig. 1.

Description.†—The corallum forms dense, roughly convex tangles of usually cylindrical stems, from 10-12 mm. thick, somewhat closely packed, but with a comparatively small amount of fusion between them, for the wavy or zigzag stems remain free far down into the mass. This waviness is due to the fact that the forking does not always result in the formation of two prongs. One only develops where there is room for it, the others merely forming "knee-bends." In the centre of the stock, which may rise to about 18 cm. in height (with 26 cm. width), the living layer is only about 3.5 cm. deep, the stems being here most crowded. At the sides, where they are more straggling, the living layer may extend to about 5 cm. The dead parts are covered with white epithecal films, which sometimes appear to have free edges.

The calicles appear to be about 1.5 mm. in diameter. The walls are slightly raised, incomplete and straggling on the younger parts of the coral at the tips. Elsewhere they appear to be only slightly zigzag, often straight, and then with slight swellings which are quite insignificant in size as compared with the irregularly round or oval granules which represent the septal granules near the wall. These are very irregular in size and shape, and also very irregularly joined to the wall, either by short thick waists or by thin plates. The same irregularity is seen in their junctions with the pali, which are also exceptionally large irregular granules. When the pali are very large the septal granules are small, and *vice versa*. Hence the symmetry of the calicles is very much obscured by the varying sizes and irregular junctions of the granules which fill it up. There are usually five pali and a central tubercle, irregularly developed, sometimes absent.

A cross-section shows trabecular and horizontal elements about equally developed, but very irregularly, here with large meshes, there with small.

This account of the calicles is based upon the enlarged photograph given by Dr. Vaughan

* Five were collected.

† See footnote to last heading.

(l.c. pl. xxxi. fig. 1). A comparison of these calicles with those shown on the same coral, pl. xxx., suggests that, as a rule, the calicle skeleton is less crowded with granules. The same irregularity in size and in the joining together of the elements can be seen in both, but it appears as if in pl. xxxi. fig. 1, a part had been photographed where the skeletal elements had been slightly hypertrophied, owing, perhaps, to excessive crowding in the part to which the fragment belonged.

While I do not deny that this may not be of the same "species" with Lamarck's *P. furcata*, it does not appear to me to have the form of *furcata*. Portions of the type of Lamarck's coral have been illustrated by Milne-Edwards and Haime in their "Monographie des Poritides"• (see also Pl. XII. fig. 1). The conspicuous features of the older figures are the amount of fusion between the stems, the distinct open fossæ, and the marked trabecular texture of the skeleton, seen in sections, and even in side view of the calicles. These are differences which cannot be ignored. With this form compare Plate XIV. fig. 1, which represents No. 182 i in the Paris Museum, from some unknown West Indian locality.

50. *Porites* Porto Rico 5. (*P. Porti-Riconis quinta*.)

[Porto Rico, coll. Vaughan; U.S. National Museum.]

Syn. *Porites astræoides forma a* Vaughan, Bull. U.S. Fish Commission, 1900, ii. p. 317, pl. xxxii. and xxxiii. fig. 1.

Description.—The corallum forms hemispherical masses, the lower margins of which may hang free of the supporting mass of previous growth-stages, upon which it is perched like a cap. The surface is raised all over into smaller hemispherical eminences, all reaching to about the same height, and separated by a conspicuous system of deep, narrow valleys. Traces of similar systems, though on a smaller scale, are seen starting upon the eminences.

The calicles (1.5 to 2 mm.) are typical of those forms in which the walls are rather regularly reticular, and consist, seen from above, of stout filaments. The median wall-thread is frequently incomplete, so that the septal plates stand up. The septa vary considerably in length, some short and pointed, others longer and knobbed, others again here and there fusing together, so that the typical septal formula of *Porites* can be made out. There is an irregular columellar tangle, with a central tubercle which is often flattened in the directive plane.

This description is based upon Dr. Vaughan's text and excellent photographs. The rudiments of a third cycle which he mentions is very rare in *Porites*, and requires fresh investigation—a matter always difficult in the case of walls built up of a reticulum, for they are usually so confused that the morphological values of the details can no longer be deciphered. I would suggest that the explanation of their presence is that the calicles which show traces of the third cycle are to be associated with double calicles. These happen to be especially numerous in Dr. Vaughan's photograph of his *forma β*.

• Ann. Sci. Nat. xvi. (1851) p. 21.

This coral is another illustration of the growth principle formulated on p. 15, that the eminences on massive forms roughly repeat the normal shape of the stock itself.

51. *Porites* Porto Rico 6. (*P. Porti-Riconis sexta*.)

[Porto Rico, coll. Vaughan; U.S. National Museum.]

Syn. *Porites astræoides* forma β Vaughan, Bull. U.S. Fish Commission, 1900, ii. p. 318, pl. xxxiii. and xxxiv. fig. 2.

Description.—The corallum is massive and more plano-convex than hemispherical, with fewer eminences than the last and of a different shape. They rise very gradually as smooth gently sloping plano-convex mounds, separated by concave valleys here deep and narrow, there broad and shallow.

Over the mounds the calicle walls are thicker and the calicles larger, from 1.5 to 2 mm., whereas on the smoother intervening valleys they are only 1 mm. in diameter. The calicles are typical of the astræoid *Porites*, see p. 142, but in this case the wall reticulum is not only much slighter but tends to be more flaky. The septa are slender points, long or short, and not showing any conspicuously radial arrangement.

This description is again taken from Dr. Vaughan's text and photographs. Once more, in giving it a separate place, I do not say that this is of a different *species* from that of the coral last described. I simply describe it as a very distinct and definite form assumed by *Porites*. What is more, it can be shown that the differences which characterise these "*P. Astræoides*" are definable and illustrate a principle of growth not hitherto recognised. But even apart from this principle, a glance at Table III. p. 130, shows us that the expanding and massive forms fall into natural divisions. These divisions might just as well be recognised directly rather than indirectly as, according to the present tendency, so many *formæ* of an imaginary species, "*astræoides*." It appears to me an impossible task to say where to limit the *formæ* and where to start new species. Dr. Vaughan himself makes a new species for such a form as *P. Brazils* 2 (= *branneri* Rathb.), and would certainly point to the differences between the calicles of that form and those typical of the astræoid group. I feel sure, therefore, of Dr. Vaughan's support in the limitation of the use of that term here suggested, see p. 142. My method of designation frees us from having to attempt to express opinions as to the limits of species, at least at this early stage of the inquiry.

52. *Porites* St. Domingo 1. (*P. Domingonis prima*.)

[Gonaïve Island, coll. Prax; Paris Museum.]

Description.—This corallum rises in the centre of a wide explanate base into a low blunt cone, which itself consists of jagged conical peaks sloping in serrated angular ridges from the centre.

The calicles have thick walls of irregular woolly-looking reticulum. On the tops of the ridges, they appear to be so thick as almost to close the apertures of the calicles. Just below

the surface, the filaments of the wall reticulum change into flakes. From the surface of the wall knobbed strands arise, some of which slope downwards into the fossa as septa. Such septa always appear as if they ran up into the walls; ordinarily the septa appear as vertical rows of knobbed points, sometimes fusing together in pairs. The columellar tangle is large and compact, with or without central tubercle, and surrounded by a ring of small, deep, inter-septal loculi.

The skeletal elements are not smooth, but tend to be angular and slightly frosted.

This astræoid *Porites* is preserved as No. 187c in the Paris Museum as *P. astræoides*. It is of special interest to us, for it affords the most striking illustration of the principle formulated above, see p. 15. We have described hemispherical forms with hemispherical eminences, and here we have a sharply jagged form with jagged eminences. This description is taken from my notes and very rough pencil sketch; the latter hardly allows me to describe the eminences exactly; still so much is clear that this form is a striking illustration of our principle.

JAMAICA.

No true *Porites* from Jamaica has, so far as I know, been yet described. The *Porites reussiana* of Duncan * from the Upper Clarendon Beds—for an account of which see below, p. 159—is, as Dr. Vaughan suggested,† a *Litharæa* (= *Goniopora*).

Records of branching forms occur. For instance, Duerden‡ mentions the occurrence of two forms, one growing especially in areas covered with the sea-grass *Thalassia* in Bluefields Bay, and the other on the shallow parts of the "actual reef" at the same locality, greyish, very brittle, growing in clumps. It is quite possible that no description of them was thought necessary, because, according to the prevailing view, they would be thought to belong to the two imaginary species *furcata* and *clavaria*.

Group IV.—WESTERN SHORES OF THE GULF OF MEXICO.

53. *Porites Belize* 1. (*P. Belizei prima*.) (Pl. IX. fig. 1.)

[Belize, coll. M. Bocourt; Paris Museum.]

Description.—The corallum appears to rise as a thin, short, central stem, about 1 cm. thick. The forking or branching is very divergent, at angles of about 90°, the branches being cylindrical or slightly flattened. There is an appearance of the terminals being represented by irregular tufts of three mammillate branchlets, 7 to 8 mm. thick. The living layer is 4 cm. deep. These stocks fall over and form a tangle from which new stocks develop.

* Quart. Journ. Geol. Soc. xxi. (1868) p. 8.

† Bull. Mus. Comp. Zool. xxxiv. (1890) p. 250.

‡ Journ. Inst. Jamaica, ii. (1899) p. 619.

The calicles are small, slightly more than 1 mm. in diameter, angular, never quite superficial. The walls are sharp, thin, and straight, rarely zigzag. The septa project from the walls and form septal granules. In older, shallower calicles the septal granules are near the wall, but appear to be distinct from it as a second outer ring to the pali, here and there even rising like the pali. The fossa is deep and obscure, and out of it the pali rise as long thick rods in the older calicles, but in the younger they are small, ragged and irregular. They are mostly six in number, the directives being sometimes distinguishable. The columellar tubercle is small and slightly flattened.

The colour of the unbleached stock is a yellowish-brown.

This description is taken from my notes on, and a rough sketch of a specimen in the Paris Museum (No. Z 182 *h*). Pl. IX., fig. 1. is a photograph of the specimen, and shows that its method of branching is different from that of any other known form. It has no resemblance to that figured by Dr. Vaughan* as *P. Porites forma divaricata*, which branches at much smaller angles and seems to have more of an axial stem.

In this coral the largest axial stem arising from the tangle appears to break up early into three almost symmetrically diverging branches, which gradually curve upwards, and each at its tip seems as if dividing irregularly. This branching requires further investigation and comparison with that of other specimens of the same coral found at the same spot. In the meantime this account is hardly exact enough to be used as a definite case of triple forking. The photograph does not support it, and the appearances can be explained more easily by rapid and irregular divisions of the tips into two.

54. *Porites Belize* 2. (*P. Belizei secunda*.) (Pl. I. fig. 6; Pl. XVII. fig. 7.)

[Belize, coll. J. Smith; British Museum.]

Description.—The corallum is nearly hemispherical, the living layer extending down the sides irregularly to 2, 3, or 4 cm. of the substratum. The surface is greatly roughened, not only by the larger convolutions from 1–2 cm. across, which show a tendency to form a slight ridge or keel, but also by smaller ridges roughening the larger and by sporadic risings of the calicle walls.

The calicles are of all sizes from 1.75 mm. in diameter on the ridges and convolutions to 0.5 mm. in the valleys. The larger have polygonal wall-ridges with open circular fossæ; the smaller are sharply angular and crowded together, with only rudimentary intervening wall frameworks. These rise up into sharp conspicuous lines, here smooth, continuous, and not very zigzag, there broken up into rough, irregular denticulations. The wall ridges everywhere tend to rise into sharp points in the angles and thus still further roughen the surface. The septa commence as small, sharp pointed projections from these ridges, and slowly lengthen as they descend in the calicle; they are fairly symmetrically arranged and show but very faint indications of meeting and fusing. The columellar tangle is so open and straggling that the calicles on the uppermost part of the stock are the deepest I have found in the genus; but

* Bull. U.S. Fish Commission, 1900, ii. p. 316, pl. ii. fig. 4.

gradually down the sides, with a central tubercle as its most persistent element, the tangle gets more and more condensed and conspicuous, until, near the edge of the colony, it fills up the base of the fossa at a moderate depth. The interseptal loculi show irregularity in sizes, some being very large.

In the only exposed section, the trabeculæ are well developed ; they are fairly far apart and joined by horizontal pieces, together making a rectangular network.

Besides this, there is another massive form from Belize, and according to the view of those who consider all the massive forms to belong to one or two species, this second would have to be classed with that just described. But the first thing we want to know is, what are the facts? and here are two massive forms from the same locality, yet differing in growth-form, in surface-markings and in the structure of the calicles. It is impossible to deny that they may ultimately prove to be of the same "species," but until this is established, we have nothing to do but follow the facts, and those are confined to what we can discover from a comparison of the two on the lines laid down above. For the striking differences they present, see the observations under the next heading.

a.

Zool. Dept. 57. 12. 16. 5.

55. **Porites Belize 3.** (*P. Belizei tertia.*) (Pl. I. fig. 7; Pl. XVII. fig. 7a.)

[Belize, coll. J. Smith; British Museum.]

Description.—The corallum, a large, long, oval, massive form, appearing as if built up of a number of convex oval plates, the margins of the plates hanging down all round to the substratum, here free, there closely encrusting. Some continuity of growth, however, doubtless persists in the central region, but on this puzzling growth problem see § IV. of the Introduction, p. 20. The whole stock is about 12 cm. high by 20 cm. across by 25 cm. long. The surface is thrown up into so many nearly separate, bluntly angular waves of all sizes with smooth slightly convex spaces between. These waves are conspicuous and about 1.5 cm. high, and it is noticeable that they repeat the shape of the whole stock (see p. 15).

The calicles show as circular pits. The fossæ, which can alone * be measured, range from 1 mm. downwards, on the tops or slopes of the waves, to minute angular breaks in some of the valleys. The walls consist everywhere of an elegant, open, angular, filamentous reticulum, the free ends of which form septal points and otherwise toss freely in different directions. There is no trace of symmetry in this network, and even when in the valleys it is thinned down, it shows hardly any tendency to return to the typical zigzag wall-thread. These walls are thickest, up to 1 mm., on the waves, and may be either fairly smooth and flat or else surge up; they are thinnest and most straggling in the valleys. They give the whole surface a soft woolly aspect. The septa are short, very irregular points which descend to the rather open,

* This therefore supplies us with no sure basis for comparison with other forms; the ordinary measurements are from wall-ridge to wall-ridge.

irregular, columellar tangle. The interseptal loculi are consequently very irregular in size and arrangement, there being generally one or two much larger than the rest.

In section, the network shows as a fairly close streaming of fine trabecular elements.

This and the coral last described are typical encrusting forms of the astræoid type. They are interesting for two reasons: first, they both show very clearly the growth-principle pointed out on p. 15, the mounds repeating the shape of their stocks, cf. the figures 7 and 7a on Plate XVII.; and secondly, that though they are both typical of those *Porites* usually called *astræoides*, and are, moreover, from the same locality, they differ very greatly in almost all their most important details. *P. Belize 3* differs from 2 in its oval outline, its soft woolly surface, its reticular walls, and irregular radial symmetry, whereas *P. Belize 2* is hemispherical, with hard-looking surface, sharp-ridged walls and pronounced septa. Both have pronounced trabeculæ, but in the one case crowded, in the other far apart. Both have a straggling columellar tangle and very irregular interseptal loculi, but the calicles in the second specimen are somewhat shallow over the whole stock. There is indeed, hardly a structural feature which, when closely looked at, is the same in both. Related the two forms undoubtedly are, but we do not know how.

a.

Zool. Dept. 57. 12. 16. 2.

VERA CRUZ.

From Vera Cruz come records of *Porites*, but so far no descriptions that I have found. An explanate form, 10 cm. longest diameter, mammillated owing to its being crumpled and folded, but in reality, apparently not more than 5 to 6 mm. thick, was found on the Caletta reef in the harbour. It was growing on an anchor which had been five years in the water.*

Other massive forms called *astræoides* are said to be abundant among massive corals of other genera in the inner waters.

Branching forms are found in fragments in great quantities on the shingle of the Islands Verde and Sacrificios, but the actual grounds where they grow were not discovered. These fragments are said to be of "*Porites furcata*."†

* See Heilprin, Proc. Acad. Nat. Sci. Phil. (1891) p. 75. The author, calculating the thickness alone, suggests that the rate of growth would therefore have been only 1·25 mm. in a year—that is in thickness. Explanate forms are those in which the growth is most active round the edges, while the centre remains nearly stationary. We have clearly to distinguish between the growth of individual polyps and the growth of the colony by budding. The author's calculation refers chiefly to the former growth; the latter is of course much greater, and was nearer 2 cm. annually in this case.

† Id., op. cit. (1890) p. 303.

Group V.—FLORIDA AND FLORIDA REEFS.

56. *Porites Florida* 1. (*P. Floridae prima*.) (Pl. XII. fig. 2.)

[Tampa Bay, Ballast Point (Miocene); British Museum.]

Description.—The corallum rose on a stem about 2 cm. thick, and early divided into an irregular whorl of 3 or more branchlets, the individuals of which bend up immediately into a close cluster, and become the new stems. They vary greatly in thickness, from 2 cm. to 1 cm. These again, when they have room, divide into fresh whorls, branchlets from neighbouring whorls fusing together. Where there is no room for development, branchlets may be early aborted, and persist only as slight excrescences, or as mammillate processes. The edges of the living layer, which was at least 9 cm. deep, tended to creep down over the dying basal stems.

The calicles were distinctly depressed, and about 1·25 to 1·5 mm. in diameter. The walls appear to have consisted almost entirely of smooth, wavy flakes, not very porous, nor very much incised laterally, the septa starting as very fine thin points standing out rather sharply and suddenly from the edges of the flake, with only slight incurving between them. These sharp, thin septa seem seldom to have been free, but curved round irregularly to join the wavy flakes which rose in the calicle as the columellar tangle. The symmetry seems to have been entirely confined to the rings of rounded interseptal loculi.

In the section, very thin, but fairly regular trabeculae can be seen, but the thin, wavy, lamellate, horizontal layers are very marked.

This specimen is a silicified Miocene fossil, which presents morphological features of very great interest. The details are difficult to obtain, but what can be made of its growth-form shows traces of an irregular whorl formation already noted, as perhaps consisting of three prongs, e.g. *P. Belize* 1, p. 67. Here they might be due to the terminal swellings, dividing not into 2, but into 3, 4 or 5 prongs, which then bend up into the vertical, perhaps fusing with those of neighbouring whorls.

This is again one of the few branching *Porites* at present known with the horizontal elements of the skeleton so markedly lamellate, that it shows in the structure of the calicles at the surface (cf. *P. West Indies* x. 17, and Pl. V. fig. 5). I assume that the surface exposed was the original true surface; it certainly looks like it, inasmuch as each calicle still shows as a depression.

It would certainly be of interest to search among the living *Porites* in the neighbourhood of Tampa to find if this remarkable form has any survivors. Such characters as these would be easy to recognise.

a.

Geol. Dept. R. 2343.

57. *Porites Florida* 2. (*P. Floridæ secunda*.) (Pl. III. fig. 8.)

[Florida Reefs, coll. Agassiz and Thomson ; British Museum.]

Syn. *P. clavaria* Pourtales (*non* Lamarck), Mem. Mus. Comp. Zool. vii. i. (1880), pl. xii. figs. 4, 5, 6.

Description.—The corallum divides into cylindrical stems about every 3 cm., and at rather small angles. The branches tend to bend up into the vertical, and, though smooth, show signs of slight swellings at points where they failed to fork, apparently from want of space. The tips are round and blunt, from 1 to 1.5 cm. thick, and consist of a streaming laminate reticulum, out of which calicles are being differentiated. The living layer extends 3.5 to 4 cm. down the cluster, which is short, stout, and squat, but showing graceful curvings into the vertical.

The calicles are about 1.5 mm. in diameter, conspicuous and not deep. The walls appear at their edges to consist of a smooth glistening thread, very thin and running in an irregular zigzag, giving off short septal processes at the angles. This is the condition near and below the tips, but lower down the branches, just below the edges of the wall, the skeletal elements thicken so suddenly as to make it appear as if the thread-like edge rested upon a shelf, from the inner edges of which the stout septa rose up to the level of the thread. In such calicles which become more and more pronounced, the wall-thread is more or less polygonal, and runs clear of a ring of radial septal plates. The inner edges and tips of the septa, quite smooth near the tips of the branches, are finely echinulate in the more adult portions and frequently swollen. Five pali, round-topped and conspicuous, rise up in the middle, sometimes connected with septa. In the centre is the columellar tubercle, which rises to the height of the pali. To these pali and central tubercles, other small irregular granules may now and then be added outside the ring of pali, but without visible connection either with septa or pali; all these obscure the fossa.

This specimen is that represented by the figures referred to above in the synonymy. It is remarkable for the change in the character of the calicles, which is very striking, even to the naked eye. Those on the upper portions have the ragged openly-reticular appearances, characteristic of so many of the West Indian forms, while down below there is a precision not often met with, and which the artist in the original figure, No. 5, attempted to bring out. But inasmuch as the specimen was not sufficiently cleaned of animal matter, he did not succeed in giving the exact details. The thin edge standing upon the suddenly thickening wall—sometimes joined to the septa, sometimes free from the septa, sometimes even wanting between two rows of exsert, radial, septal plates—has so far not been recorded for West Indian forms. The new figures here given bring out the differences in the calicles.

The slightly fusiform shape of the branches has been already noted, see p. 59; while the sudden thickening of the elements just below the surface is seen again in *P. Florida* 5 and in *P. Bermuda* 1 (see p. 143).

a. Presented by Sir John Murray.

Zool. Dept. 91. 2. 3. 19.

58. *Porites Florida* 3. (*P. Floridae tertia.*)

[Florida Reefs, coll. Agassiz; ? U.S. National Museum, Washington.]

Syn. *Porites furcata* (*partim*) Pourtales (*non* Lamarck), tom. cit., pl. xvi. figs. 13 to 20.

The following two descriptions are taken solely from the beautiful figures cited.

Description.—The corallum rises as a cylindrical, but gradually thickening stem, about 1 cm. thick. This divides at small angles into short, straight, though slightly swollen, branchlets, which may, or may not, again divide. The coral dies rapidly away, the living layer being only 2.5 to 3 cm. deep. The tips of the branchlets are round and blunt.

The calicles appear about 1.25 mm. in diameter, and fairly conspicuous. The walls are represented without any clear, sharp, median thread, but as an elegant filigree as if due to innumerable rounded incisions in flakes. The septa show the same characters, only thinning away towards their tips. Each of the peripheral margins of the interseptal loculi is thus not a single curve but a succession of curves separated by sharp points: similar points run irregularly out along the septa. Where the septa terminate, a ring of bushy pali continues this filigree character, fainter and fainter, into the fossa.

There can be no doubt that the trained eye of the artist of this beautiful figure has given accurately the character of the skeleton as he saw it, and it is sufficiently remarkable to justify us in saying that such a form cannot be regarded as a mere variation of *Porites furcata* Lamarck. There is no specimen like it in the National Collection.

59. *Porites Florida* 4. (*P. Floridae quarta.*)

[Florida Reefs, coll. Agassiz; ? U.S. National Museum, Washington.]

Syn. *Porites furcata* (*partim*) Pourtales (*non* Lamarck), tom. cit., pl. xii. fig. 7.

Description.—The corallum forms short, rather expanding tufts. The stem forks at wide angles, but the lower prong may not develop, its place being marked as a smooth swelling or thickening of the branch, which appears to bend upwards above it. Stems and branches, though varying greatly, show little diminution in average thickness, being about 1 cm., and the living layer 3 to 4 cm. deep.

This description is based upon the original figure above referred to. There is no figure of the calicles.

The classing of this with the specimen last described as both variations of the same species, and that species Lamarck's *furcata*, is only possible when our units are imaginary species, the elasticity of which is practically unlimited. There can be very little doubt that

the calicles differed as much as the growth-forms. Their methods of forking, the shapes of the terminals, are all different. We confidently claim these as two distinct Floridan *Porites*, which must claim attention on their own account, and can no longer be lost sight of as accidental variations of the form called *P. furcata*, by Lamarek. On this last coral see below, p. 82.

60. *Porites Florida* 5. (*P. Floridae quinta*.) (Pl. III. fig. 9; Pl. XI. fig. 2.)

[Florida Reefs, coll. Agassiz and Thomson; British Museum.]

Description.—The corallum rises as thin, cylindrical stems, of uniform thickness, slightly over 1 cm., the lower portions being sometimes thinner than the upper. The forkings take place some 4 to 6 cm. apart, and between them the stems are usually slightly curved, each point of curving looks as if it might represent an aborted attempt to fork. The forking is at fairly wide angles, the stock being open, and with long, thin, straggling branches. The two prongs of each fork are unequal in size; the thicker one seems to be but slightly deflected from the line of growth, the thinner one to stand out from this line as a branch. The living layer is 5 cm. deep. The tips of the branchlets are round.

The calicles are subcircular, from middle of wall to middle of wall, 2 mm. across, with open fossa 1.25 mm. The fossæ make the calicles conspicuous. Near the tips the wall shows along the edge as an incomplete zigzag thread, thin, irregular, and giving off septa, thin, short, and ending in frosted granules. From the base of the fossa, small frosted granular pali arise, with here and there a central tubercle. This character of the skeletal elements extends some distance down below the tips, where the calicles open in the central, reticular, lamellate stroma. As the coral thickens, however, the skeletal elements also thicken, until the thin thread and small granules are purely superficial, and scattered on the surface of broad, solid, smoothly granular, or nodulated walls, or on a solid nodule-like columellar tangle, which fills the base of the fossa, leaving the interseptal loculi as 12 deep, elongated, and very irregular pits. The fossæ gradually get shallower, and the thick septa stouter and longer, until they meet irregularly together and with the pali, on the surface of the solidified columellar tangle.

The section shows the axial reticulum, of thin skeletal elements, surrounded by a peripheral portion, showing no conspicuous, horizontal, or radial elements, but simply as a dense, irregular mass, of large glassy nodules fused together, and with pores and cavities between.

This *Porites* is remarkable for its scanty, divaricate branching. It differs from all similar stocks which open out by wide forking; see, for instance, *P. Curaçoa* 1. For the known divaricate forms, see Table III. p. 136.

The sudden thickening of the skeletal elements just below the thin surface filigree is a phenomenon already noted, but with different results in the aspect of the calicles, see e.g. *P. Florida* 2; see also *P. Bermuda* 1. (See p. 143, Appendix to Table IV.)

a. Presented by Sir John Murray, K.C.B.

Zool. Dept. 91. 2. 3. 15.

61. *Porites Florida* 6. (*P. Floridae sexta*.) (Pl. IV. fig. 1.)

[Florida Reefs, coll. Agassiz, Harvard College Museum ; and coll. Thomson, British Museum.]

Syn. *Porites astræoides* Pourtales (? Lamarck); Mem. Mus. Comp. Zool. vii. i. (1880) pl. xvi. figs. 1 to 12, 20, 21.

Description.—The corallum rises into regular, nearly smooth, hemispherical masses, with surface slightly but distinctly convoluted, being covered all over with smooth rounded eminences of different sizes, from 1 to 2 cm. in diameter, and separated by narrow but convex valleys. The living layer extends all round down to the substratum.

The calicles are deep subcylindrical pits. The walls consist of a stout, smooth, zigzag thread, here and there tending to be reticular and showing a few wall pores. The short, smooth, stout septa project from the wall in such a way as to seem to continue the curving angle of the zigzag ; this looks as if septa and wall-thread had been produced out of one piece by the excision of rounded interseptal loculi. The tips of the septa are slightly swollen. These septal processes descend vertically down, showing no signs of protruding further into the calicle, and ultimately join the close solid-looking tangle, which shows signs of smooth round pores in it, and is separated from the walls by the symmetrical ring of deep, round, interseptal loculi.

The sections show the pores here quite irregular and there in vertical rows, regular enough to produce trabeculæ.

This description is based upon the beautiful drawings, referred to above, of the original specimen. Two drawings are given of the calicles : in one (fig. 4) the wall-thread and septa are smooth-topped and on the same level ; in the other, the walls are incomplete and the septa appear to be exsert.

There is, fortunately, a specimen in the National Museum which may possibly be of the same kind, inasmuch as it is from the Florida reefs, and was presented to this Museum by Sir John Murray. But there are differences. It is not hemispherical, having grown up into a ridge on one side, while the other has crept outwards and downwards. The eminences on the ridge are themselves sharp-ridged. The walls are more flaky than is shown in Pourtales' fig. 4. Although the generally lamellate texture of the skeleton, both trabecular and horizontal, is as shown in the sections, figs. 21 and 22, the illustration here given, Pl. IV. fig. 1, which is of the Museum specimen, shows the whole skeleton as a very flaky network, it being quite easy to see, except where the wall-edge has risen as a filamentous tangle, that the septa run out as thin sharp points from the edges of flakes.

These two corals, then, are only provisionally put together ; they agree in the general type of calicle, which is that which is usually known as astræoid, but they show important differences in growth-form in that the one is hemispherical with hemispherical eminences, while the other forms somewhat of an irregular ridge with eminences also tending to be ridged. In this latter case, also, the skeletal texture is more flaky. More specimens are needed to see whether these are separate local forms. The Florida reefs might certainly be expected to produce more than one kind of explanate or massive form.

a. Presented by Sir John Murray, K.C.B.

Zool. Dept. 91. 2. 3. 36.

Group VI.—BAHAMAS AND BERMUDA.

62. *Porites Bahamas* 1. (*P. Bahamæ prima*.) (Pl. IV. figs. 2, 3, 4, 5, 6; Pl. XVII. fig. 8.)

[Nassau, coll. Melillo; British Museum.]

Description.—The corallum is convex, closely encrusting, and in all the central regions covered with small rounded or steeply convex eminences, but laterally spreading out smooth and thin.

The calicles have deep conspicuous fossæ, the largest 1.25 mm. on the rounded humps, the smallest, often angular, are in the valleys. They become shallow as they near the thin edges. The walls are usually very thick and round-topped in the central regions, but flat round the edges. They consist of a flaky reticulum with rounded pores through the flakes; the topmost edges of the latter are frequently filamentous, but show the flakes in the lower levels. The septa project a very little way as thin, insignificant and irregular processes from the edges of the flakes, here and there with slight lateral projections like the teeth of a saw. They descend vertically downwards in very incomplete rows, yet seen from above they separate deep, short, round, interseptal loculi. The base of the fossa is filled with a large, flaky, columellar tangle from the surface of which skeletal processes arise irregularly from the edges of the flakes. Where the calicles are shallow, that is, round the edges of the stock, a few septa may join with these columellar processes as bent irregular bars, but hardly any traces of the typical symmetrical formula of *Porites* can be made out. Round the edges there may be a width of some 2 to 3 mm. of the flaky reticulum, with hardly any signs of calicles.

The specimen *a* from Nassau, above described, is interesting because it is one of the nearest approaches to a cœenchymatous West Indian *Porites* so far known (see Table IV. p. 139). The walls thicken here and there to as much as 2 mm. In texture, they are sometimes more flaky, at others more filamentous, see Pl. IV. fig. 2.

But the specimen is interesting also for another reason. It shows that small patches of calicles with very thick walls are not always normal. There are two patches on this specimen which show the calicles thus affected, in both cases, apparently by the proximity of foreign organisms. Pl. IV. fig. 4 shows a spot where the polyps of a *Mussa* (the skeleton of which is still *in situ*) must have come into inconvenient and irritating proximity with those of the *Porites*, with a result that the skeleton proliferates as there shown; while again, Pl. IV. fig. 3 shows a patch where the proximity of some foreign body is demonstrated by the sudden flattening of the surface. This question was brought up once before, in the observation on *P. Guadalupe* 6, with its two kinds of calicles. A certain amount of variation, due to natural structural differences, is always to be expected, but it is well to know that very striking differences may be due to accidental interferences with growth.

a. With a young colony *e.*

Zool. Dept. 87. 4. 26. 8.

In addition to this there are three other specimens, all showing essentially the same characters, such as the steeply convex eminences and general calicle structure, though, as a rule, with thinner walls.

Specimen *b*, also from the Bahamas, encrusting a piece of a glass bottle, but without nearer locality, has the same characters as to growth, shape of humps on the surface, and the position of these, this is, in the central region. The walls differ in being much simpler. A slightly zigzag median thread forms a keel, from each side of which the short septa slope slightly down, and then descend vertically round the large deep fossa. Where these walls thicken they form a stout filamentous network, the nodes of which rise up over the surface as short blunt processes. Pl. IV. fig. 5 is taken from the thin expanding edge, where it creeps over the smooth glass.

b. Encrusting a piece of bottle.

Zool. Dept. 86. 10. 13. 11.

c (Pl. IV. fig. 6) has the same keeled walls as *b*, but the columellar tangle is more open, and consequently looks deeper, and there is frequently a central tubercle visible.

The stock is differently grown. It appears at one time to have encrusted a smooth surface like that of a bottle, but having apparently been unable to spread laterally, successive growths have built up a tall narrow ridge. From some unrecorded locality, but presumably belonging to this group of Bahama specimens.

c.

Zool. Dept. 91. 1. 16. 1. (part).

d is a small rounded knob showing a median keel along the walls. The septa have a tendency to be knobbed like the typical septal granules of the Indo-Pacific forms, and within them traces of pali with a large central tubercle appear in the fossa.

This again, has no locality, but the Register No. shows it was acquired with *c*. It is associated with a fine specimen of *Diploria*, which is a well known West Indian coral.

d.

Zool. Dept. 91. 1. 16. 1. (part).

e. Underneath the stock *a* is a small encrusting patch, apparently of a very different *Porites*, with very shallow calicles; the flattened walls being a zigzag of narrow, angular, skeletal threads, from which nodulated, bent, and angular septa project. The fossa seems filled up with irregular skeletal elements, among which pali may be recognised.

But for the tendency to produce saw-like septa, seen in specimen *a*, showing as knobs in specimen *d*, I should have classed this separately, though with the evidence for the changes which position and accident can produce in specimen *a*, it is safest to regard this as a young colony growing in a very unfavourable position.

e. Growing on *a*.

Observation.—From Mr. Rathbun's Catalogue * we note that specimens called *astræoides*, *clavaria*, and *furcata*, from the Bahamas, are preserved in the United States National Museum. The *astræoides*-like specimen is from Nassau, and might, perhaps, be the same as *a*. A comparison is desirable.

* Proc. U.S. Nat. Museum, x. (1887) pp. 354, 356.

Specimens called "*clavaria*" mingled with others called *furcata* are also recorded from Nassau. The former are said to have been the stouter forms, branched to a very limited extent and provided with small crowded cells, but they have the general habit of the species *clavaria*. Here we find the Author following the suggestion of Pourtales, that the names *clavaria* and *furcata* could be used descriptively. As above shown, there is no historical nor morphological justification for such a use of the names. The confusion it led to is described in the Introductory Historical review, p. 3.

63. *Porites* Bermuda 1. (*P. Bermuda prima*.) (Pl. IV. fig. 7; Pl. XII. fig. 4.)

[Bermuda; British Museum.]

Description.—The corallum is a large, confused tangle of short, thick stems, matted together into an almost solid mass, upon the shell of an *Arca*. All but the uppermost surface was dead, and the produce of previous growths. From this surface, stems about to fork, and single branchlets arise, covered by the living layer for varying distances from 2 to as much as 6 cm. deep. The forking seems to take place at intervals of about 1 cm., hence the whole is compact and squat, and the short, blunt terminals frequently taper rather suddenly and irregularly.

The calicles are large, 1.75 mm. in diameter, and conspicuously pitted without being deep. The walls are raised as an exquisitely delicate, filamentous zigzag, quite smooth and often incomplete. The septa start also as short, equally delicate processes, each with a minute, frosted or lobate knob at the tip. Below the rim of the wall, and this uppermost tier of septa, the skeletal elements rapidly thicken, and the same details are repeated in stouter and finely echinulate elements. From these thicker, deeper septa, a ring of delicate pali, each tipped with a small lobate knob, rises nearly to the height of the wall. Although the formula of 5 with a minute central tubercle can be made out, its real symmetry is not easy to unravel.

The section is interesting because it shows the trabeculae as thick, irregular, and flame-like, and ending at the surface in very thin, delicate points and spikes, forming the wall trabeculae and the pali. The surface, in side view, consists of a forest of thin rugged spikes mostly with minute knobs at their tips.

This coral, of which there is only one specimen, was, according to the custom, labelled *Porites clavaria* by Brüggemann. Its very squat growth-forms, and the peculiar character of the skeletal elements at the growing surface are sufficient to differentiate it.

The stock was apparently suffering from some malady. Small, smooth nodules, sometimes recalling uprisings of tabulae to the surface, as if the polyp had to defend itself against some intruding foe by walling it round and over, occur here and there all over, while patches of 1 cm. square and less, quite killed down, are found on almost every terminal.

For the sudden thickening of the skeletal elements just below the surface, see *P. Florida* 2 and 5.

64. *Porites Bermuda 2.* (*P. Bermudæ secunda.*) (Pl. IV. fig. 8; Pl. XII. fig. 3.)

[Bermuda, coll. 'Challenger'; British Museum.]

Syn. *Porites clavaria* Quelch (*non* Lamarck), Chall. Rep. xvi. (1886) p. 179.

Description.—The corallum rises from a dead tangle of previous growth, over which it sends out creeping edges. The basal stems are short and very thick, (*ca.* 3 cm.) and forking rapidly about every 2 to 2.5 cm., the rounded terminals are about 1.2 cm. thick. The living layer may extend some 9 cm. from the terminals to the basal encrustation of the dead tangle.

The calicles are only faintly pitted, and appear in the bleached coral as delicate long-rayed stars, somewhat smaller (1.25 to 1.50 mm.) on the terminals than they are on the basal stems (1.5 to 2.00 mm.). The walls show variations in thickness, they are for the most part thin zigzag lines, rugged and nodulated as are the septa, and sometimes incomplete, but here and there this is replaced by a fine foaming network with round pores or meshes and smooth threads. The septa project at different levels as rugged, very echinulate rods which soon join a large, close, columellar tangle; small rugged pali arise and a still more obscure central tubercle. The typical formulæ can be traced both in septa and pali though somewhat obscured by the roughness of the skeletal elements.

The section shows a very open, subrectangular network of trabecular and horizontal elements, with large rounded meshes; the polyps extended some 3 mm. into the coral, and tabulæ are pronounced.

This coral has no claim that I can see to be identified with the West Indian form called by Lamarck "*clavaria*." It is obvious from Mr. Quelch's text that he was following the lead of Pourtales, and was uncertain whether to call it *clavaria* or *furcata*. Lamarck's *clavaria*, see p. 81, branched more freely, and at the terminals had thin raised walls, and pali sufficiently well developed as to show a distinction between the five principal pali and the one on the dorsal directive.

There is one large specimen showing the growth of the stock upon a fragment of a dead tangle, and a box of smaller pieces.

a.

Zool. Dept. 86. 12. 9. 310.

b. Four fragments.

,, 92. 10. 16. 19.

65. *Porites Bermuda 3.* (*P. Bermudæ tertia.*) (Pl. IV. fig. 9.)

[Bermuda, coll. A. E. Shipley; Cambridge University Museum.]

Description.—The corallum is branching; the short, cylindrical basal stems are smooth and swollen, slightly over 2 cm. thick, and forking dichotomously at wide angles about every 2 cm. The small, rounded terminals flatten a little before dividing, and are a little less than 1.50 cm. thick.

The calicles range from about 1·25 mm. on the terminals, to 1·75 to 2 mm. on the thick stems. The walls are broad, flat-topped, and solid-looking, as if composed of a thick, granular, zigzag thread, with projecting septal points, all thick and as if about to fuse into a solid wall-mass, striated across. The septal projections from the wall are blunt, rounded knobs. Within the circle of these the fossa descends steeply as a subcircular pit, in which a ring of short, stout, granular pali, with large rounded knobs, rises nearly flush with the wall, and there with the columellar tubercle seeks to fill up the calicular depression. The whole surface of the coral appears thus smooth, granular, and solid; while in the section, the thick trabecular and concentric elements form an irregular, close network, neither of them being regular or conspicuous. The elements rapidly thicken till the section becomes very compact, except right in the axis, which consists of a delicate, streaming, axial network, which at the tips of terminals appears at the surface.

This coral, with the usual name *P. clavaria* upon its label, is in very striking contrast to No. 1 of this Bermuda group. Though in both cases the stems are short, they fork so rapidly in No. 1 as to form very few neatly cylindrical stems, such as we have here; while, lastly, the surface of the colony is the direct opposite of this, it is a delicate raised filigree; here it is all smooth and flattened, the granular elements being thick and fused together into a nearly solid layer.

The only specimen known is that in the Cambridge University Museum.

Dr. Verrill, in his account of the Bermuda Islands (Trans. Connect. Acad., xi. pp. 485, 505), mentions large masses, 2 feet in diameter, of encrusting *Porites*, which he called *P. astræoides*, of a bright yellowish-brown colour, and also a branching form which he called "*P. clavaria*."

Specimens called both "*astræoides*" and "*clavaria*" are recorded from Bermuda by Mr. Rathbun as being in the U.S. National Museum.* The *astræoides* of Bermuda are said to have larger calicles than those from Florida reefs, and to be one of the commonest in "the shallow waters about the Bermuda reefs, ranging from low tide level to depths of 2 to 3 fathoms."

Group VII.—SPECIMENS FROM UNKNOWN ATLANTIC OR WEST INDIAN LOCALITIES.

This section contains descriptions of *Porites* from unrecorded localities, which, however, are, either from the label or from other recognisable characteristics, known to belong to these Atlantic and West Indian areas. The section thus contains descriptions of such interesting forms as the original specimens of Lamarek's *P. clavaria* and *P. furcata*, which as imaginary species have so long dominated the minds of workers in this field. The descriptions are based upon notes made in Paris soon after the completion of Vol. III. They were

* See Proc. U.S. Nat. Mus. x. (1887) p. 354.

thus made at the beginning of my apprenticeship to this difficult group, and consequently before the results obtained during the preparations of Vols. IV. and V. were available. Still, inasmuch as they are illustrated by photographs taken for the purpose in the Paris Museum under the express direction and supervision of Dr. Charles Gravier, they are sufficiently near to be able to support the serious arguments which I have here based upon them.

66. *Porites* West Indies *x. 1.* (*P. Americana incertæ sedis prima.*)

Syn. *Madrepora Porites* Solander, Zooph. (1786) p. 172, pl. xlvii. fig. 1.

Description.—The corallum rises in stout stems which appear to swell, flatten slightly, and then either fork at right angles, or else break up into clusters of nearly spherical knobs of different sizes. The living layer appears to extend about 6 cm.

The calicles are neatly polygonal. The walls very thin, incompletely and slightly zigzag. The septa, of irregular lengths and roughened, project freely into the fossa, that is without any union with pali, or columellar tangle. The pali are represented as a ring of small points, with a still smaller columellar tubercle at the centre.

This description is based upon Ellis and Solander's well known figure. Its interest is not only historical, inasmuch as Lamarck referred to it as specifically identical with the specimen which he called *P. clavaria*, but actual. The growth-form is peculiar. It has all the aspect of being a West Indian form, but the forking is very irregular, and entirely unlike that of Lamarck's own *P. clavaria*, the forking of which is neat and orderly, see fig. 1 (Pl. XIII.). This marked difference between the growth-forms of the two was apparent to Duchassaing and Michelotti, who in their *Mém. sur les Cor. des Antilles* called it *P. Solanderi*, and identified it with a form they had found at St. Thomas (see p. 57); but this latter identification was dropped in the Supplement to that treatise, which appeared in 1864.

The illustration of the calicles, though too superficial, yet shows a type which ought to be recognisable again. Nevertheless we rely mainly upon the growth-form for its recognition. This latter is remarkable enough, and unlike that of any other West Indian *Porites* I have seen, either as an actual, or as a figured specimen. If it is a normal form, our only chance of finding its relationships is when collections are again made from its proper locality. If it is abnormal, it will be of very little future use for the building up of our knowledge of the group.

67. *Porites* West Indies *x. 2.* (*P. Americana incertæ sedis secunda.*) (Pl. XIII. fig. 1.)

[Paris Museum.]

Syn. *Porites clavaria* Lamarck, Animaux sans Vertèbres, ii. (1816) p. 270.

Description.—The corallum rises as a stout cylindrical stem, which forks regularly and dichotomously at about every 2 cm. apart and at a wide angle, but showing a tendency for the prongs to bend up into the vertical. The stems and branches are all of nearly uniform

thickness from 1.5 to 2 cm. They flatten slightly before forking, and the terminals have short rounded tips about 1 cm. thick. Though the stems approach closely to one another, they show no tendency to fuse together. The living layer is more than 11 cm. deep.

The calicles are superficial except at the extreme tips, where the walls rise as sharp irregular zigzags. Elsewhere the wall is not very distinct, the septa starting right from its top edge. These latter, as they start from the wall, are very short, mostly free and slightly knobbed, but not so distinctly as to form a second ring of septal granules round the pali which rise from a lower level. The ring of pali is compact, small, but very conspicuous; it shows the five principals and a smaller directive palus noticed in the description given by Milne-Edwards (Les Cor. iii. p. 175). The columellar tubercle is at a lower level than the pali as the pali are at a lower level than the peripheral portions of the septa. The calicle is well filled with skeletal elements showing no deep open cavities into the interior. Cross sections even near the tips are compact.

This description is founded upon notes made of the specimen, No. Z 182 e, in the Paris Museum, which I take to be the original type of Lamarck's *Porites clavaria*. That Lamarck had a specimen and was not referring either to Solander's specimen (see p. 81), nor to Seba's from Curaçoa (see p. 30), we gather from the words "*mon cabinet*"; certain indications lead me also to think that this is the specimen which Milne-Edwards described, excepting that he gave the thickness of the stems far too large.

The locality of the "species" was given by Lamarck as *Les mers d'Amérique et de l'Inde*. But the label on this specimen says, "Antilles, coll. Lamarck." The Indian Ocean may have been added to cover corals thought to be specifically identical. At any rate it is clear that this particular specimen is a West Indian form. The review of the Indo-Pacific *Porites*, given in Vol. V. of this Catalogue, showed no specimen whatever which we could unite with it as even possibly of the same species. See the Historical Introduction, p. 3, on the way this name *clavaria* has been used. The simple accident of its having been the first specimen described, and described as a species in the first systematic work of importance dealing with the corals, has given it a fictitious value, which it is to be hoped is unique in the annals of systematic zoology. Whereas, beyond its description, all that can be said of it is that it belongs to some local form, which has apparently not yet been re-discovered.

68. *Porites* West Indies *x. 3.* (*P. Americana incertæ sedis tertia.*) (Pl. XII. fig. 1.)

[Paris Museum.]

Syn. *Porites furcata* Lamarck, Animaux sans Vertèbres, ii. (1816) p. 271.

Porites furcata Milne-Edwards and Haime, Ann. Sci. Nat. (3^e) xvi. (1851) p. 21, pl. i. figs. 1, 1a, 1b, 1c.

Description.—The corallum rises into clusters of cylindrical stems, which fork or attempt to fork, at distances of from 1.5 to 2 cm. and at angles of about 90°. Diverging prongs tend always to bend up into the vertical, and in the centres of dense clusters fusions become

frequent.* Elsewhere the stems are long with curves due not only to aborted forkings but also to the bending upwards of diverging prongs. The living layer in the looser peripheral stems is from 5 to 6 cm., but in the crowded central stems between 3 and 4 cm. deep. Epithecal films appear.

The calicles are uniformly about 1 mm. in diameter, nearly flush with the surface, except at the growing tips, and polygonal. The walls are a tall, thin, open latticework showing from above as a zigzag thread, smooth, neatly filamentous, sometimes thin. The septa branch off from the walls as smooth filaments, but mostly soon swell into frosted or sharply echinulate granules; at a lower level the septa join a smoothly filamentous columellar tangle, which is either a ring surrounding a deep open fossa ("*petite fossette*"), or a true tangle with a columellar tubercle rising from it. A ring of five pali rises from this tangle as large echinulate knobs or rods. Their symmetry and order are obscured by the loose open texture of the skeleton, which allows one to see down into the depths of the coral.

This is the description of the type of Lamarck's *Porites furcata*. The original stock (in the Paris Museum) appears to have been an immense tangle of crowded stems, the bulk of which were kept together by being embedded in some cement. Great fragments of it have, however, again become loose. The piece figured by Milne-Edwards is one such, probably from near the centre of the stock, for the branches are densely crowded and fused together. Other fragments much more open, and even dendroid, are preserved; one such, No. Z 182 d, and here figured, was found classed among the *Porites clavaria*.

Lamarck referred to the specimen figured by Morison (Plant Hist. iii. sect. 15, plate x. fig. 12) in 1699, as a possible synonym. That specimen seems to have been in the Ashmolean Museum, Oxford. Inquiries at Oxford have so far elicited no information. The figure suggests a *Pocillopora* rather than a *Porites*.

Referring to the specimen itself and its type of growth, we see how unfounded is the suggestion which has been adopted by so many recent writers that Lamarck's *Porites furcata* represents a different type of growth-form from *clavaria*. If there is to be a *furcate* type, let there be one by all means, but let it be understood that it does not rest upon Lamarck's coral. It may be an advantage to have a *clavate*, a *furcate*, and a *divaricate* type of stock, including respectively, forms which fork at short distances, at medium distances, and at long distances apart. If so, they should be deliberately adopted as so many convenient descriptive terms required by the modern analysis of the differences discoverable in the specimens, without any implied relationship with Lamarck's or Lesueur's specimens.

Lamarck included in the same "species" another coral as a variety which is also, fortunately, still preserved in the Paris Museum as No. Z 187 a. This will be described under a different heading, see next page. It helps to explain Lamarck's text.

The concluding observation to the *P. West Indies* v. 2, applies to this coral as well.

* The figure given by Milne-Edwards represents fragments from the crowded centre of a large stock.

69. *Porites* West Indies x. 4. (*P. Americana incertæ sedis quarta.*) (Pl. XIII. fig. 4.)

["Les Mers d'Amérique," coll. Lamarck ; Paris Museum.]

Syn. *Porites furcata* var. 2 Lamarck, Animaux sans Vertèbres, ii. (1816) p. 271.

Description.—The corallum rises in stems which flatten out into tall, thin, erect plates 1 cm. thick and less, and much bent. The top edges of the plates divide into fringes of branches which may be either cylindrical and tapering, or else compressed apparently prior to leaf formation and subsequent forking into two or three fresh branches. The leaf edges are about 5 mm. thick ; the forking is at very small angles. The living layer extends about 3 cm.

The calicles are small, about 0.75 mm., slightly depressed. The walls near the top are thin, ragged, and flaky, with a few very irregular, knobbed septa projecting from the edges of the flakes ; the pali are distinct as small granules only gradually forming a ring. Lower down the walls widen, and thin septal ridges rather long and in small groups of *parallel* (not radiating) striæ run over the surfaces of the flakes. Where the septa do not thus striate the walls, the latter is covered with distinct granules like the pali, and the whole surface is covered with small, frosted, whitish points standing up above the dead, black, animal matter. In these older calicles the pali are larger and usually six in number, forming a ring round a deep conspicuous fossa.

This specimen, No. Z 187 *a* of the Paris Museum, and labelled as from "Les Mers d'Amérique," is the var. 2, *lobis ultimis compressis* of Lamarck's *Porites furcata*. Milne-Edwards and Haime identified it with Dana's *Porites conferta*, which was the *Madrepora conglomerata* of Esper. This coral is discussed below, p. 157, where it is regarded as having been a *Goniopora* from Madagascar. It would seem that Milne-Edwards' description is founded more upon Esper's figure than upon Lamarck's coral.

It should be noted that there are no specially West Indian characters about this specimen, and in placing this and some of the following forms here I am frankly assuming that the words "Mers d'Amérique" apply to the West Indies.

The black colour of the dead matter on the stock is in contrast with the brown colour of the type, and the point is especially noted by Lamarck that some of the forms are coloured brown and others black by the dead animal matter upon them.

There seems to be a second specimen of this same coral in Paris, viz. No. Z 187 *c*, which has upon it a young disk-like colony, quite smooth and flat, from the middle of which a thin short round-topped digitiform process suddenly rises. This young colony is interesting, because we know so little about the initial stages of these West Indian branching corals, see e.g. *P. Barbados* 10, p. 42. The flattening and dividing of the tip of this central boss may be the origin of the leaf formation, which is also shown in this second specimen, only not so marked as in the type because its top edges divide much faster into clusters of digitiform processes.

70. *Porites* West Indies *x.* 5. (*P. Americana incertae sedis quinta.*) (Pl. XIII. fig. 5.)

[“Les Mers d'Amérique,” “coll. Lamarck”; Paris Museum.]

Description.—The corallum forms erect, rather stiff clusters of flattened stems, which fuse edge to edge to form flabellate plates, showing lines of fusion. As each component stem forks into two sharp teeth, the uppermost edge of the plate runs out into a row of short tapering points, like the teeth of a saw. The tips of these are 4 mm. thick, the stems 1.5 cm. The living layer is 7 cm. deep.

The calicles increase from 0.75 mm. at the top, where they are deep, to 1.25 mm. at the base, where they are shallow. They are funnel-shaped, angular, very variable in shape, as regular polygons, or drawn out into slits. The wall has a sharp, median ridge, as a clear white line. In older, more regular calicles, the septa are very irregular, being short, thick, and wedge-shaped, with here and there a half-separated granule at their tips. These stray granules are apparently the only representatives of the usual pali formula. In smaller and younger calicles the radial symmetry is quite obscured, and the walls of the calicles are encrusted on their inner sides with granules, which slope down round a deep, open, sometimes very large fossa.

This description is that of a specimen in the Paris Museum (No. Z 187 *b*); it is labelled “*P. furcata*, coll. Lamarck; Mers d'Amérique.” This coral and the last are interesting, because if named by Lamarck at all, they show that he had a different interpretation of the word *furcata* from that which has been recently adopted by authors who have written upon the West Indian *Porites*. The latter, by *furcata*, have meant rather more open branching; Lamarck meant more like a fork with sharp prongs.

The condition of the calicles is remarkable; the depth of the fossa, with the absence of pali, are noteworthy characters which, though rare, are not unknown in the genus; we have it normally in the astræoid group and occasionally in some of the Indo-Pacific forms.

This *Porites* ought to be easy to identify again. Although in view of the doubt as to the authenticity of the record on the label, the locality “Mers d'Amérique” is, in this coral, also open to suspicion. (See the observation under the last heading.)

Pl. XVI. fig. 4 represents another coral in the Paris Museum (No. Z 187 *m*), with an exactly similar record on the label. It again differs from any yet described.

71. *Porites* West Indies *x.* 6. (*P. Americana incertae sedis sexta.*)

[This is the specimen preserved in the Berlin Museum and recorded as from the Red Sea, and named *Porites clavaria* Ehrenberg, Corallenthiere des Rothen Meeres (1834) p. 117; and renamed *Porites nodifera* Klunzinger, Korallthiere des Rothen Meeres, ii. (1879) p. 41, pl. v. fig. 17, pl. vi. fig. 13.]

This coral has already been described in Vol. V. p. 239. I was aware, at the time, of the suggestion that the record of the locality might have been accidentally changed, and that the

specimen was from the West Indies and not from the Red Sea, and that consequently the name *clavaria* given by Ehrenberg could have stood.* I did not adopt the suggestion because my Paris notes led me to believe that Lamarck's type specimen of *clavaria* is a very different kind of coral, certainly as to growth-form (see p. 81). I now, however, recognise that the habit of the specimen, both as to growth and calicle structure, as seen in Klunzinger's photographs, make it nearly certain that it did come from the West Indies. We, unfortunately, know no more of its real locality than we do of that of Lamarck's type.

72. *Porites* West Indies *x.* 7. (*P. Americana incertæ sedis septima.*) (Pl. XVI. fig. 4.)

[“ Les Mers d'Amérique, coll. Lamarck ”; Paris Museum.]

Description.—The corallum rises as a thick stem, about 2 cm. in diameter, which forks fairly regularly and sharply, at angles of about 60°, and at from 1.5 to 2 cm. apart. The terminals are about 1.5 cm. long, tapering and flattening. The living layer is at least 5 cm. deep.

The calicles are very conspicuous and angular, and about 1 mm. in diameter, but not very uniform in size. The walls are everywhere raised as a thin, sharp network. At the edges of the walls the septa appear as slight, granular projections, but lower down at a nearly uniform depth below the wall-edges they run out as wedge or tongue-shaped flakes, the tips of which sometimes fuse, but generally swell into pali. The ring of pali is thus separated from the wall by a clear flat-bottomed trough; and is distinct and conspicuous even to the naked eye. It is often complete, the lateral principals being large. The fossa is large and conspicuous, sometimes with a very minute central tubercle.

The coral is another of the Paris *Porites furcata* (No. Z 187 m). A first glance at the figure with its sharp tapering terminals suggests *P. West Indies x.* 5, but the calicles are entirely different, as indeed is the growth-form also, when closely examined.

Whether this is one of Lamarck's original *furcata* or not, it is now impossible to say. The association between the name and the shape of the specimen is obvious.

73. *Porites* West Indies *x.* 8. (*P. Americana incertæ sedis octava.*) (Pl. XIII. fig. 2.)

[West Indies, coll. Michelin; Paris Museum.]

Description.—The corallum rises into thin branches, of irregular thicknesses and shapes, though chiefly cylindrical. They fork at angles of about 30°, but slowly and not regularly.

* See for instance Vaughan, *Sammlungen des Geol. Reichs. Mus. zu Leiden*, ser. ii. bd. ii. heft 1 (1901) p. 74.

Before dividing, the stems flatten to straight, chisel-like edges, 2 cm. wide and more, and less than 1 cm. thick. The living layer extends from 5 to 6 cm. downwards. The coral dies progressively upwards, without extrusion of tabulate or epithecal films.

The calicles are about 1 mm. across, deep at the growing tips, and gradually getting flush with the surface at the lower edge of the living layer. The wall-thread is irregular, seldom very zigzag, and gets gradually coarse and thick; the wall itself descends steeply into the calicle. The septa are short, thick and truncate, rather than knobbed. The radial symmetry is not easy to make out, except for the six to seven deep open holes representing the interseptal loculi. A coarse thread represents the columellar tangle; it is sometimes a ring which surrounds an open fossa; from it the pali rise as thick, but slightly tapering rods, sometimes very large, but nearly always very irregular. Five principals can occasionally be made out.

This is the description of another of the Paris Museum specimens (No. Z 182 *k*), named *Porites clavaria*. It again shows the typical forking of the West Indian branching forms, with a remarkable specialisation in the sharp, chisel-like edges of the terminals. Once again, here is a method of growth quite unlike that of the type of Lamarck's *clavaria*, or, indeed, any other I have yet seen.

74. *Porites* West Indies *x.* 9. (*P. Americana incertae sedis nona.*) (Pl. XIV. fig. 2.)

[West Indies, coll. Michelin; Paris Museum.]

Description.—The corallum rises into an expanded tuft, from a basal stem, somewhat thin, but irregularly flattening and swelling. This departure from the usual symmetrically cylindrical stems and the irregularity of the forking, is characteristic of forms with thickening stems and branches (see Table III. E. *d.*, p. 136). The living layer is 2.5 cm. deep. Distinct epithecal rings appear.

The calicles are 1 mm. in diameter, angular, but never quite superficial. The walls are thin and steep, appearing at the surface as granular threads, very often incomplete. The septa are very irregular in length, being frosted granules when projecting from the sides, but longer when projecting from the angles of the calicle walls. The ring of pali is conspicuous, as five frosted granules; the fossa is here and there open, though mostly with a columellar tubercle.

The skeleton is open and loose with large interseptal loculi. The colour is a very pallid buff.

This is another of the Paris Museum specimens (No. Z 182 *j*), which has been placed with Lamarck's *clavaria*. But it obviously belongs to the unknown West Indian forms, inasmuch as the growth shows an interesting variation on a type of branching already mentioned several times (see e.g. *P. Porto Rico* 3), only here there is some indication that the swollen tips are chiefly flattened (see remarks under *P. Guadalupe* 2, p. 43).

75. *Porites* West Indies *x.* 10. (*P. Americana incertæ sedis decima.*) (Pl. XIV. fig. 3.)

[Paris Museum.]

Description.—The corallum rises into a compact clump of short, thick, knarled branches, apparently produced by the forking of a stem at small distances, that is, at about every 0.5 cm. apart—and at considerable angles. The prongs are short and round. The stem and branches are too irregular to measure, but appear to be about 1.8 cm. thick.

The calicles are 0.75 mm. in diameter, rather deep. The walls are thin and steep. The internal skeleton is irregular and rather deep down. The septa are stout, often long, thick and either truncated or joining the pali. The latter rise from a columellar ring as long, thick, coarse, truncated rods; in the more regular calicles, the five principals can be made out. There are six to eight large, open, interseptal loculi.

This specimen, No. 182 *e* in the Paris Museum, has been somewhat distorted by Balanids, but appears also to be referable to the branching West Indian forms, and to be one in which the forkings take place in rapid succession.

76. *Porites* West Indies *x.* 11. (*P. Americana incertæ sedis undecima.*)
(Pl. XV. fig. 2.)

[Paris Museum.]

Description.—The corallum rises into open tufts of short, flattened, angularly twisted branchlets. The tips seem to fork at very wide angles, the terminals being also flat and angular. The living layer is 4 cm. deep. Epithelial films creep over dying edges.

The calicles are 1 mm. in diameter, everywhere depressed, of irregular outline, either very angular or subcircular. The wall-thread is hardly visible, though the walls themselves look stout, being thickened by the large granular bases of the septa. The septa themselves often project from the walls—short, thick, swollen and truncate—sometimes united together to form an inner synapticular ring. The five principal pali are arranged in a large circle, somewhat below the surface and surrounding either a small, deep, open fossa or a central tubercle.

The skeletal elements are generally coarse and thick.

The forking of this specimen, No. Z 182 *g* of the Paris Museum, is again irregular and the order of it difficult to make out. The result certainly presents us with a new type of growth-form which appears to be deducible from the more regular type by variation in the methods of forking and the shapes of the terminals. The specimen requires closer study. It is placed here because its growth-form may be regarded as a variation of the dichotomous branching of the West Indian forms, and it is one of the Paris Museum specimens labelled "*clavaria*."

77. *Porites* West Indies *z.* 12. (*P. Americana incertæ sedis duodecima.*)

Syn. *Porites macrocephala* Duchassaing and Michelotti, Mém. sur les Cor. Antilles, Suppl. (1864) p. 95, pl. x. fig. 15.

Description.—The corallum rises into a mass of stems—apparently thickening irregularly as they rise—some remaining nearly cylindrical, while others swell into great inverted cones, flat-topped, and with irregularly wavy and bulging sides. These processes are about 7.5 cm. high and from 5 to 7.5 cm. thick.

The calicles are very small (*"perparvis"*), crowded, reticulate and depressed. The walls and septa are thin, and there is usually no columella.

This *Porites*, as representing an entirely new type of growth-form, is of importance. It is neither an ordinary encrusting or massive form, nor a branching form, yet it may have been derived from the same kind of early stage as the latter. In this case, the rising corallum, instead of forking, expanded into a great top-heavy mass, like an inverted cone.

We have here then a form which could not possibly be classed in any of the imaginary Lamarckian "species." It is interesting, because it enlarges the range of possible growth-forms. It is unfortunate that its locality is not given; we may note, however, that the bulk of Duchassaing's specimens were either from St. Thomas or Guadalupe. Its type seems to be lost; I did not see it in Paris, nor is it in Turin, since no photograph of it was included in the photographs of Duchassaing's types kindly sent by Count Peracca for this volume.

78. *Porites* West Indies *z.* 13. (*P. Americana incertæ sedis tertiadecima.*)

(Pl. V. fig. 1; Pl. XIV. fig. 4.)

[British Museum.]

Description.—The corallum rises into thick, flabellate, basal stems, 2 cm. thick, 2 cm. wide at the start, and expanding rapidly to 5 cm., where it breaks up into a crowded series of irregular digitiform processes, some very thick, some very thin, forking and reforking very irregularly, but always at very small angles and moreover bending towards the vertical, so that there is but little expansion of the cluster. The forking results in unequal prongs, one often very thick, the other very thin, the thinner often persisting for considerable lengths. The living layer is only 2 cm. deep on a cluster 13 cm. high.*

The calicles are large, open, subcircular, shallow depressions, about 1.8 mm. in diameter. The wall is thin and sharp, and consists of a wall-thread, frequently wanting, running in an open very pronounced zigzag. The septa are irregular as smooth threads, swollen frequently into minute conspicuous clusters of echinulæ. Where the joining threads are not seen, these echinulate granules appear to form the septa. The calicle symmetry largely depends upon the

* See, however, observation below.

arrangements of wall- and septal-granules and pali, while beneath this system of surface granules the skeletal elements are arranged as a continuous, open, filamento-flaky network with angular meshes. The pali are very inconspicuous, and the columellar tubercle is very small.

The sections show an immense axial strand which seems even to thicken in the larger branches and terminals. The surface layer nowhere seems to become dense. The colour of the living layer is a dark blue-grey.

This specimen is of very great interest. It has, unfortunately, no recorded locality other than "West Indies," and seems further to have suffered from the fact that calcareous worm-tubes run over it. We therefore do not know how far the depth of the colony is normal.

The branching is not very typical of West Indian forms, although it might easily be deduced by flattening from some pear-shaped initial colony. Among its points we note: (1) the bluish-black colour of the unbleached branches; (2) the irregular forking with persistence, and even continued growth of thinner prongs; (3) the calicles, as thin-walled, large, concave depressions; (4) the tendency of the septa to break up into echinulate granules; (5) the feeble development of pali.

We have here again one more type of growth-form with which systematists will have in the future to reckon and place in their proper series. Such series can only be begun when we have rid the work of phantom species.

a.

Zool. Dept. 39. 3. 29. 10.

79. *Porites* West Indies **x. 14.** (*P. Americana incertæ sedis quartadecima.*)
(Pl. V. fig. 2; Pl. XIII. fig. 3.)

[British Museum.]

Description.—The corallum rises on a small cylindrical stem, 1.5 cm. thick, and forks regularly at about 1 cm. apart, and at angles slightly under a right angle. The prongs, until they flatten and fork, are again about 1.5 cm. thick, and cylindrical. The stock is thus squat and thick, but it is not simple, because it appears from a study of the forkings that each pair of prongs is slightly twisted out of the plane which it would have occupied with symmetrical dichotomous forking. These twists seem to follow some regular principle. The living layer is about 3.5 cm. deep.

The calicles are large and uniform, about 1.6 mm. in diameter, subcircular and conspicuous. The wall-edges, which, in the younger parts, are a delicate, open, crisp network, showing a thin irregularly zigzag wall-thread, gradually change into what appear to be continuous, smooth flakes, which, in reality, represent the rapid thickening of the skeletal elements. The short septa, with crisp, echinulate, septal granules at their tips, project boldly from the wall, only meeting together lower down in the general, open tangle, which fills the floor of the calicle. From this the pali arise as star-like, echinulate granules, similar to those at the tips of the septa projecting from the edge of the wall. The symmetry of the interseptal loculi and of the pali is obscured by the crisp, echinulate edges of the septa and other elements

composing the intra-calicular skeleton. The colour of the unbleached coral is a rich, warm red-brown.

The section shows a very open, axial reticulum of streaming flakes, gradually thickening into an irregular, closer, but not dense, cortical network of thick skeletal elements which are thick right to the surface, except in the younger parts which consist mostly of the axial reticulum.

This coral, with its rich red colour, its apparently regular, dichotomous forking—each fork just twisted on its own stem—is typically West Indian in every detail of its growth. It is unlike any other in the collection. It is unfortunately rather young, and it is to be regretted that the effect of the twisting of the forkings cannot be followed on an older stock. That this twisting is not accidental is obvious, because it occurs in each case, that is in the first and second forkings, and traces of it can be seen in the third which is just commencing.

But for this twisting, it would be the most perfect case of symmetrical dichotomy yet recorded. This raises the questions as to how often we ever get the true, normal growth of any coral? Are not most of them interfered with by currents and foreign organisms, affected by their positions, on which depend the physical conditions with regard to light, gravity, density of water, etc.?

a.

Zool. Dept. 39. 3. 29. 8.

80. *Porites* West Indies α . 15. (*P. Americana incertæ sedis quintadecima.*)
(Pl. V. fig. 3; Pl. XVII. fig. 20, a.)

[British Museum.]

This *Porites* grows upon a fragment of a Gorgonid skeleton; it is one among a group of corals—both *Porites* and *Astræids*—scattered about upon the same object. The other *Porites* appears to be different from this. It is at first somewhat surprising to find two or possibly three different *Porites* growing together and yet so distinct. The natural suggestion is that currents may have swept great numbers of coral larvæ through the open branchwork of the Gorgonid skeleton, and several different kinds have managed to attach themselves to it.

Description.—The corallum forms small smooth colonies, which may encircle the stems of the Gorgonid skeleton, or on a flat surface remain thin and explanate, that is, show no convexity, even when as much as 1.5 cm. across. The edges are very thin.

The calicles from median wall-thread to wall-thread are 1.5 mm. in diameter, and, but for the small gradually incurving fossæ, superficial. The walls, or rather the interfossal tissue is thick and smoothly round-topped, curving upwards out of one fossa down into the next. To the naked eye a faint median wall-thread or line appears. Magnification, however, shows it to be only an arrangement of the sharp angular wall granules somewhat straighter than elsewhere. When the top granules are rubbed off, the reticulum is seen to be composed of flakes, mostly horizontal but tilted, deeply incised and perforated, though sparsely, with small round pores. At the surface the granules show traces of being arranged fairly regularly into radial

septal rows, and very irregularly into concentric rings. The most conspicuous of these rings has twelve granules, which may, perhaps, be regarded as the "septal" granules; but the rest of the granules, viz. those which might be regarded as pali on the inside, and wall granules on the outside, are too confused for us to be able to unravel the elements with any satisfaction. The fossa is deep, and its base is filled up by flaky tissue showing no symmetry.

The colour of the unbleached coral is a cold dark grey.

This coral is interesting as being one of the few West Indian *Porites* which show any approach to being cœnenchymatous, cf. *P. Bahamas 1*, p. 76. Parts of other explanate West Indian *Porites* show great thickening of the walls, see Table IV. A, p. 139, but this is, so far, the only form in which the wall proliferation extends over the whole stock, and is so pronounced.

There are traces of five stocks of this *Porites* scattered over the Gorgonid skeleton. The one figured is the largest intact specimen. Two others, which at one time grew round the stems, have since been overgrown by the branching forms; see the two descriptions following.

Underneath the explanate root-base of the Gorgonid, which had been overturned, two small, flat, explanate stocks of the same kind, apparently unable for some reason or other to fuse, sought to overlap one another. This is what one would expect, because though fusions of *branches* certainly take place here and there, it is of interest to note that it is far more frequently avoided.

In view of the recent tendency to claim all the explanate West Indian forms as of one and the same species, *astræoides*, this specimen is welcome as enabling us to take some decided stand against such a purely theoretical limitation.

a. On a Gorgonid skeleton in five small stocks.

Zool. Dept. 43. 3. 6. 98 (part).

The other *Porites* upon the Gorgonid were originally placed under separate headings, for they appeared to be very different (cf. Pl. V. figs. 3, 4). On revision, however, I believe they may be regarded as two variations of the same. They hardly admit of being described together, and consequently the two descriptions are now included under the same heading.

81. *Porites* West Indies *z.* 16. (*P. Americana incertæ sedis sextadecima.*)
(Pl. V. figs. 4, 5; Pl. XVII. figs. 20 *β*, 20 *γ*.)

[British Museum.]

This coral encircles the Gorgonid skeleton, and when securely fixed, grows up into short, thick, branching lobes. Of the two specimens, one of them, *a*, has only just begun to rise into branches which have been unfortunately broken off, while the other, *b*, has developed lobes.

Description.—The corallum spreads as an explanate creeping base, which encircles the stems of the Gorgonid skeleton, enveloping at the same time other encrusting corals. The edges are stout but sharp. From its surface processes arise, the shapes and methods of branchings of which are unknown.

The calicles (on the base) are 1.5 mm. in diameter, mostly polygonal, shallow but

distinct. The walls are straight; where a wall-thread is visible, it is very thin and only faintly zigzag. The septa branching from its angles are thin and short, but swollen at their tips. The chief variation in the coral is due to the swelling of the peripheral portions of the septa into enormous granules, which then show like a row of large knobs along the wall, mostly obscuring the wall-thread. Within this row of knobs there is, though very irregularly, a second ring of (septal) granules, and within this again the pali (5) with central tubercle. The fusions of the septa are obscured, the whole surface being very neatly granular. The granules, seen sideways, rise like short bristles, and are neatly arranged into concentric rings within polygonal areas marked off by rather larger granules. The section of one of the erect processes shows a small, central, streaming axis surrounded by stout, dense, irregular reticulum.

This coral appears as if it were the expanding base of a branching form, and in order to have a safe foothold, it had nearly to encircle the stem, and in doing so, cover up a stock of the coral last described. The neat mosaic of granules or short bristles is not too crowded, but sufficiently spaced and differentiated as to render the calicles conspicuous. This kind of surface is quite peculiar and differentiates the form especially from the associated *Porites* found in the same specimen, and described as No. 15. The upright processes had only just started; the one persists as a small irregularly mammillate process, and the other is broken off, but appears to have been about the same size. It is possible that both of these may have been stimulated to growth by Balanids and thus not be the beginnings of true branches at all; on the other hand, the calicles are not like those usually associated with West Indian massive or explanate corals.

a. On Gorgonid skeleton in one small stock.

Zool. Dept. 43. 3. 6. 98. (part).

Specimen b.

Description.—The upper surface rises into a nearly straight row of large lobes or knobs, arranged along the length of the coral as it encircles the Gorgonid skeleton; so close are these that any forking or bulging has in each case to grow out laterally. Most of them have been distorted by Balanids. They, with their secondary knobs, rise about 2.5 cm. high and seem to be about 1.5 cm. in diameter when they first start; for the most part, their tips are blunt and round.

The calicles are small, 1 to 1.25 mm. in diameter, very angular, conspicuous, and not very shallow. The walls are straight, thin and conspicuous, raised as straight or irregularly zigzag threads. The septal points projecting from it are few and minute, and even on the basal expansion the septa are not conspicuous round the uppermost edge; they start below it. Within and close to the walls is a ring of septal granules, and within that the pali, all small and irregular, and with a central tubercle. The fusions of the septa are deep down and obscured.

A section of a knob near the base shows great irregularity of solidification, that is, it is not confined to the cortical layer, though there it is most conspicuous, but intermingled with patches of more open reticulum.

The figures of the calicles are taken from the top of one of the upright processes, and show the more or less open axial reticulum at the tip. The basal calicles are a little more regular, and when looked at not too closely, show the same granular or bristly appearance described for specimen *a*. This feature is so rare that we have to assume that the two are of the same kind, and owe their differences to the effect of accidental conditions. On the other hand this common feature may be in adaptation to some factor of their common environment—a bristly surface might be protective against the attachment of *Balanid* larvæ, swept with others through the Gorgonid skeleton.

b. On a Gorgonid skeleton.

Zool. Dept. 43. 3. 6. 98 (part)

82. *Porites* West Indies *x*. 17. (*P. Americana incertæ sedis septimadecima.*)
(Pl. V. fig. 6; Pl. XVI. fig. 3.)

[West Indies, coll. Bowerbank; British Museum.]

Description.—The corallum rises into tall, thin, branching stems, nearly uniform in thickness (1.5 to 2 cm.), the whole way up. The forking, which takes place at irregular distances, from 2 to 3 cm. apart, seems mostly to result in one prong either forming a lateral spur, long and tapering, or short and mammillate, or even aborting altogether as a knee-like protrusion while the other thickens, carries on the stem, and again forks. The living layer is about 5 cm. deep.

The calicles are ill-defined, superficial, and yet fairly conspicuous; they are mostly small, but vary in size from 1.5 to 0.75 mm. The wall is very irregular and seems to consist of continuous, smooth, chalky-looking flakes with very crisp edges, varied in width, here wide there narrowed to a thread. Processes grow out of these flakes and swell into highly echinulate or frosted knobs; the vertical processes raise the wall; the lateral processes form the septa, the swellings of the latter form the septal granules. The septa are very irregular, sometimes broad and flaky, sometimes thin, always with crisp echinulate sides. The pali are also irregular, either as granules or as flat, crisp-edged, horizontal plates; these, like the septa, fuse together quite irregularly, and consequently obscure the radial symmetry. The central fossa, which is large, is mostly shallow and with a small central tubercle. The interseptal loculi are of all shapes and sizes, one or two usually very large and conspicuous. The tips of the terminals are rounded masses of open reticulum apparently of stout threads which are the edges of streaming lamellæ.

The section shows the axial strand not very pronounced, and the cortical layer gradually changing in the direction of considerable development of the concentric elements.

There are two specimens from the Bowerbank collection, unfortunately without any recorded locality. There can, however, be little doubt that they are West Indian forms. They are tall and slender, and might thus be easily recognised again from their growth-forms. For an extreme development of this modification, in which one prong carries up the stem and the other aborts as a spur, see *P. Barbados* 6, p. 38. The calicle skeletons, in being lamellate, are rare in branching forms; cf., however, *Porites Florida* 1, p. 71.

a, b.

Zool. Dept. 77. 5. 21. 207 and 208.

83. *Porites* West Indies α . 18. (*P. Americana incertæ sedis octavodecima.*)
(Pl. V. fig. 7; Pl. XIV. fig. 5.)

[British Museum.]

Description.—The corallum rises from a short stem, 2 cm. thick in its greatest diameter, and gives rise by irregular dichotomous forking to a cluster of wavy, nodulated stems of very irregular thicknesses, and thickening as they rise. They are mostly erect, but without fusions. They fork mostly so unequally that one, the thicker prong, carries up the stem, while the other stays behind as a small, projecting, perhaps mammillate process. The massive and swelling terminals are mostly flattened, and in the act of dividing up into two or three quite irregularly, but somewhat divaricately. The living layer is about 4 cm. deep. An epithecal film creeps up over the dying edges.

The calicles are about 1.5 mm. in diameter, and flush with the surface excepting where they are passing from the undifferentiated tips to take on adult characters. The walls at such places are thin, raised, zigzag membranes, and surround dark fossæ, from the depth of which minute pali and other processes arise. Lower down, the wall is merely a faint ridge, everywhere thin but irregular, here slightly nodulated, there a smooth filament. The septa are mostly short, and appear to consist of septal granules and pali, either touching one another or joined by very short, smooth, thin filaments. They are symmetrically arranged round a large ring of pali, six in number, the directives taking part. These pali surround a large, round, columellar tubercle.

The colour of the unbleached coral is a light brown.

The section of the basal stem is somewhat remarkable, on account of the enormous size of the axial reticulum, which is very open and delicate, and shows the cross sections of calicles with neat, open, almost petaloid, interseptal loculi, and also on account of the sudden transition of this axis into a cortical layer of radial trabeculæ.

This coral, with its clusters of erect gradually thickening branchings, recalls that described and figured by Dr. Vaughan (see above *P. Porto Rico* 3, p. 63), but that was a much larger coral, 14.5 cm. high, whereas this is but 9 cm. Its branches were also proportionately thicker and its calicles larger. Further, its stems and terminals were all straighter, more erect, and less nodulated, the terminals dividing less divaricately. The museum fortunately possesses several West Indian *Porites* with this kind of growth-form, all differing greatly in details. See further Table III. p. 136.

There are two specimens.

a, b.

Zool. Dept. 1906 1. 1. 2. and 3.

84. *Porites* West Indies *z.* 19. (*P. Americana incertæ sedis nonadecima.*)
(Pl. V. fig. 8; Pl. XVI. fig. 1.)

[British Museum.]

Description.—The corallum rises from a thin oblique stem (? overturned) from 1 to 1.2 cm. thick into a rapidly expanding cluster up wavy, forking, and gradually thickening stems; it is some 12 cm. high and 15 cm. in diameter of its nearly level top. The great number of undivided stems are due to rapid forking, without trace of regular dichotomy. They are very crowded but free, that is, do not fuse. In thickness they vary greatly, and wave about, sometimes digitiform, sometimes flabellate or irregularly swollen. The living layer is confined to the tips, is only 2.5 cm. at the deepest, and each separate tip is either a small single knob or swelling, flattening, and dividing quite irregularly, putting out divisions almost wherever there is room for them. An epithecal film creeps up over dying edges.

The calicles are small, average about 1 mm. in diameter, and shallow, though with a skeleton sufficiently open as to appear deep. The wall over all the tips is delicately membranous, and raised cup- or funnel-shaped above the surface; lower down it is a thin wall-thread, here and there becoming reticular, with flaky filamentous elements and smooth round pores or meshes. The septa are thin and delicate where they actually leave the walls, but soon swell into granules. They are very perforated, and lower down project as echinulate rods joining the pali and the columellar tangle; seen from above, the typical septal formula can be made out; seen close, the skeleton is too broken up into an apparent confusion of frosted or echinulate granules to show any symmetry. The pali rise up from the tangle as very small, irregularly star-like granules, varying in number according to the development of the directives from five to seven. There is usually a smaller central tubercle rising with the pali from an open, somewhat scanty, central tangle. The tubercle rises at times from systems of spokes of this tangle. The interseptal loculi, in spite of the echinulate sides of the septa, are large and open.

In section, the axial strand is of stout streaming network, showing the outlines of calicles very distinctly; it is not very extensive, and changes gradually into a stout, radially streaming reticulum, in which trabeculae are fairly conspicuous.

The colour of the unbleached coral is a rather deep warm buff.

This is another of the West Indian *Porites* in which the uprisings tend to enlarge as they rise, causing great irregularity in the ordinary dichotomous branching, see Table III. p. 136. The great width of the cluster rising from so small an attachment is interesting. It must have very soon become top-heavy. All the knobs into which its colony is broken up reach about the same level. The method of growth should be compared with that last described. It is very different from either the *clavaria* or *furcata* of Lamarek, while again, they differ from one another by characters which most systematists, working on the ordinary lines, would claim to be specific.

a Large stock.

1906. 1. 1. 4.

b Broken from *a*, and with two fragments, one of which is bleached.

1906. 1. 1. 5.

85. *Porites* West Indies *x*. 20. (*P. Americana incertæ sedis vicesima*.)
(Pl. V. fig. 9; Pl. X. fig. 2.)

[British Museum.]

Description.—The corallum rises into small clusters of short, thin, waving, gradually thickening branches, here somewhat flattened, there swollen or slightly constricted, and varying from about 8 mm. to 1 cm. in thickness. The forking shows signs of irregular dichotomy, but at very small angles, the prongs bending up into the vertical. Before dividing, they are frequently flattened so as to be oar-shaped, with level top ridges 6 mm. thick and 1.1 cm. long. The living layer is from 2 to 2.5 cm. deep. Epithecal films encircle the dead stems.

The calicles are small and, when round, about 1 mm. in diameter and under, but they are mostly drawn out of shape, as if the polyps had strained upwards. The apertures open obliquely at the surface, and their shapes are lengthened out in the direction of growth. Except at the growing tips, the walls are flush with the surface. The tall, thin, sparsely perforated membranes, which rise funnel-shaped round the calicles at the tips, change into ragged-edged twisted flakes sending out knobbed processes as so many irregular septa, which together with the columellar tangle and pali, seem to fill the calicle with a ragged disordered network showing but little radial symmetry. The septal formula can just be made out, the pali being small rods or granules. The flakes in the younger calicles are mostly confined to the walls, but in the older calicles they gradually extend over the whole intra-calicular skeleton.

The colour of the unbleached coral is a rather warm buff, with here and there a faint reddish tinge.

The section shows the open axial reticulum of stout lamellæ passing outwards into a much denser but irregular cortical layer.

This *Porites* is another example showing the same type of growth as that last described. See Table III. E *d*, p. 136, for the forms whose stems thicken as they rise. This one is unlike any yet recorded, and it is unfortunate that its locality is so far unknown.

a, b. Two small portions of stocks, one bleached. Zool. Dept. 1906. 1. 1. 6. and 7.

86. *Porites* West Indies *x*. 21. (*P. Americana incertæ sedis prima et vicesima*.)
(Pl. VI. fig. 1; Pl. XV. fig. 4.)

[West Indies, coll. J. Poland; British Museum.]

Description.—The corallum rises as a stout stem, 2.5 to 3.5 cm. thick, from nearly the whole surface of a small basal disk, some 4 cm. in diameter, and with cushion-like edges 1 cm. thick, the edges curving upwards on to the stem. The basal disk—or enlargement of the stem—

partly encrusts the surface of *P. West Indies* x. 25, and is partly free except that it rests upon a *Serpula* tube. The first forking seems to have taken place about 1 cm. above the base, and one of the prongs has since forked three times and always at very short distances, so that branchlets 1 cm. thick are reached at about 5 cm. from the base. The living layer of this short, squatly branching corallum extended over the whole, even curling round under the basal disk.

The calicles are about 2 mm. in diameter and shallow, but with distinct depressions which in the younger calicles are subcircular with a central boss rising in their bases. The walls are flat-topped and about 0.5 mm. thick, and the surface layer is a very delicate filigree of thin threads either as a zigzag or as an angular network, the free ends having frosted knobs. This smooth filigree is quite at the surface and can be seen rising from a much thicker, coarser network immediately below. The septa belong, for the most part, to this stouter lower layer; they are short, free, irregular, and their tips end in larger frosted knobs of the same kind. They seem even to thicken and become coarser as they descend further into the calicle.

From the confused tissue filling up the base of the fossa, in which the septa lose themselves, pali arise as a small, compact, irregular ring of four to five frosted points. There is a smaller central tubercle in the younger calicles, but in the older the pali have that peculiar rosette-like appearance shown in Milne-Edwards' figure of *P. furcata*, which was intended to illustrate the structure of *Porites*.^{*} The small frosted tip of the palus is surrounded by a frill of delicate tissue like a collar, and is either an indication of the sudden thickening of the whole palus, or the outgrowth of somewhat flaky, horizontal, skeletal matter. The edges of the septa show the same horizontal fringes.

The section shows a very open loose reticulum, in which the trabeculae are somewhat pronounced, being thick, nodulated, and separated by large round pores; the horizontal elements are also well developed, but less so than the trabeculae.

Here, again, is a branching *Porites* which differs very decidedly from any other in the National Collection. It has one character, namely, the frilling round the pali, somewhat like that of Milne-Edwards' figure above cited, and which was so unintelligible to me in that drawing as for long to discount its value to my mind. But this specimen shows it. On the other hand, the peculiar texture of the walls and the growth-forms are quite different from those shown in Milne-Edwards' figure. It is especially to be regretted that there is no recorded locality for this specimen, which grew upon an old beer bottle, and is here placed among the West Indian forms because of the character of its skeleton, and also because it grows upon an encrusting form (*P. West Indies* x. 25), which also has the West Indian type of *Porites* skeleton, see below, p. 102.

It is to be noted that the *Serpula*, upon whose tube the basal disk partly rested, became involved in the coral. It and its tube grew up with the ascending stock. Perhaps it is to the stimulation of this organism that we must attribute the fact that one of the two prongs resulting from the first forking, namely, that one in which the worm-tube ran, grew more rapidly than the other. The bottle, on which it was growing, is of an antiquated type.

a.

Zool. Dept. 1903. 7. 31. 1.

^{*} Ann. Sci. Nat. (3^e) xvi. pl. i. fig. 1a.

87. *Porites* West Indies *x.* **22.** (*P. Americana incertæ sedis secunda et vicesima.*)
(Pl. VI. fig. 2; Pl. XVI. fig. 5.)

[British Museum.]

Description.—The corallum appears to rise as a small squat cluster or tuft. Its basal stems are 2 cm. thick, diverge at wide angles from a common nodule of a dead former growth, and curving upwards fork at about every 1 cm. apart. The terminals thus rapidly produced, get smaller and smaller, and develop unequally; some flatten and commence to fork at once, others remain aborted as stout mammilliform processes of varying lengths and about 8 mm. thick. These terminals also show the tendency to bend up into the vertical. The living layer is from 4 to 5 cm. deep.

The calicles are distinct, sharply polygonal, but shallow, fairly uniform in size, 1.25 mm. in diameter. The walls are low, but thin and well-defined, the wall-thread being continuous and straight, that is, with hardly any trace of the usual zigzag. The portions of the septa springing from the top edges of the wall-thread are usually quite short as small echinulate knobs. The prolongation of the septa occurs lower down, where they stretch out and join somewhat irregularly with one another, and with a columellar ring, which, seen from above, appears as if it were continuous. From this ring the pali rise, and, for the most part, surround a deep, open, central fossa, which is at times occupied by a small central tubercle. Looking at the intra-calicular skeleton from above it appears to consist of an open network built up of short, straight, smooth threads jointed together by finely echinulate knobs at the nodes. It is very open, and the interseptal loculi are large, angular, and open. Some are as large as the central fossa.

The section shows a stout, close, axial, streaming reticulum, surrounded by a thick ring of much stouter skeleton, here fairly trabecular, there nearly solid.

There is unfortunately only one specimen, from some unrecorded locality. The manner of growth, and the type of the calicles leave no doubt whatever that it came from the West Indies. It had been labelled *Porites clavaria* by Brüggemann. But the branching, with the frequent abortion of the forking, and its stunted tuft-like growth differentiate it entirely from Lamarck's type (see p. 81). It is unlike any other form in the collection.

a.

Zool. Dept. 1906. 1. 1. 8.

88. *Porites* West Indies *x.* **23.** (*P. Americana incertæ sedis tertia et vicesima.*)
(Pl. VI. fig. 3; Pl. XV. fig. 3.)

[British Museum.]

Description.—The corallum seems to have grown up slantingly to the horizon, perhaps from the side of a rock; the short basal piece is 2 cm. across and horizontally flattened. The

forking seems to be rapid, 1 cm. apart, nearly all in the same plane, but frequently aborted, leaving knee-bends or thin rounded processes. These latter may secondarily grow in length and show one or more knee-bends, but they remain much thinner than the main continuations of the stems, which keep fairly uniform in thickness. The living layer in the single slantingly grown specimen is 3 cm. deep.

The calicles are variable in size, many 2 mm. and more in diameter, as concave, sub-circular depressions. The walls are not high, but are conspicuous, thin and sharp-edged. The wall-thread itself is frequently absent, but when developed, very closely zigzag. Where its thread is not developed, the septa of adjacent calicles are arranged close together. Here and there rows of two, three and more of these calicles run almost together, the intervening walls being very faintly traceable. The septa appear as rather irregular rows of granules, diminishing towards the centre; wall granules, septal granules and pali, with a small central tubercle, can be made out. But as the granules fuse irregularly together, they appear to vary in size and the pali vary in number. The directives frequently appear short and apart from the walls, owing to the breaking up of the edges of the septa. The central tubercle is sometimes flattened in the directive plane.

The section shows a great thickness of axial reticulum which forms the tips of the terminals, surrounded by a thick, nearly solid, cortical, trabecular layer.

The unbleached portion of the coral is a brownish-grey.

This coral is unfortunately only a single specimen, which seems to have grown out laterally at an angle of 40° to the horizon. We have no means of knowing whether this is normal or accidental. The calicles are large, and somewhat peculiar among the West Indian forms in having the septa as rows of minute frosted granules. All the rest of the characters, however, point to its belonging to this region. The sudden contrast between the delicate surface elements, and the great thickness of the elements seen in the section apparently right up to the surface has been already noted, see *P. Florida* 2 and 5, *P. Bermuda* 1, etc. (see p. 143). The axial reticulum is not only large and open, but shows in cross-sections the radial symmetry of the calicles which developed in it.

The specimen was labelled *Porites clavaria*, apparently because it somewhat resembles that figured by Ellis and Solander.* The resemblance stops at the fact that both corals consist of single forkings of stout stems, and is of absolutely no morphological importance.

a.

Zool. Dept. 1906. 1. 1. 9.

89. *Porites* West Indies **α. 24.** (*P. Americana incertae sedis quarta et vicesima.*)
(Pl. VI. fig. 4; Pl. XVII. fig. 10.)

[British Museum.]

Description.—The corallum shows a large, convex, encrusting base, 8 cm. in diameter, without free edges, and rising to about 1 cm. thickness in the centre. The surface is perfectly

* Zooph., pl. xlvii. fig. 1. See above, p. 81, for a description of this *Porites*.

smooth, except where short, stout lobes arise, which takes place where the encrusting base reaches the edge of its supporting substratum.* These lobes are 2 cm. thick where they rise from the base, but they may begin at once to flatten, and when about 2 cm. high, to fork.

The calicles, slightly indented and subcircular, are about 1 mm. in diameter, absent on the rounded tops of the lobes which are undifferentiated, flaky-filamentous reticulum. The walls everywhere consist of loose, open uprisings of this reticulum, which, when forming a wall, is mostly angularly filamentous, showing thin trabeculae, and thin, smooth, horizontal threads, here and there running together into small flakes. The wall-thread running in this reticulum is often incomplete, frequently has a pronounced zigzag. Its trabecular elements rise all over the surface as thin smooth rods, swelling into finely echinulate granules. The septa have this same character as they project from the reticular walls. The pali are everywhere well developed, as is also the central tubercle when present. This latter is, however, frequently absent, and instead, a small, deep, open fossa is conspicuous to the naked eye.

In sections the trabeculae are seen to be flaky beneath the surface, and running continuously as twisted interrupted lamellae. The colour of the stock is blue-grey, with the finely echinulate tips of trabeculae, septa and pali as whitish specks.

This coral has other interests besides its colour, on which see remarks on *P. Barbuda 1*, p. 50, and note on p. 143.

One specially interesting problem relates to its method of growth. The larger part of the specimen is encrusting, but it sends up short processes which begin to fork. The question arises as to whether this encrusting portion is only a base of what would ultimately have been a branching *Porites*. It certainly looks like it, not only in the fact of the thick lobes beginning to fork, but also in the facts (1) that the tips are of undifferentiated streaming reticulum, obviously in rapid growth, and such as is seen at the tips of most branching forms; and (2) That the character of the skeletons of the calicles, a loose, open, foaming or tossing reticulum, almost baffling one's powers of description, is quite typical of branching *Porites*, but is not at all typical of the encrusting and massive forms—cp. the astræoid group.

If this reasoning is correct, it brings the specimen still nearer to the blue branching form *P. Barbuda 1*, with which it has one other character in common, namely the deep circular fossae. On the other hand, the branches are very different in shape and thickness, and the characters of the calicles differ in their skeletal elements.

Although there is no record of the locality of this coral, its characters proclaim it as belonging unmistakably to the West Indies. See further Table III., *Ea* and *Eb*.

a.

Zool. Dept. 1906. 1. 1. 10.

* In this case, a chip of a brick, and most of the processes seem to arise where the corallum is flowing over one of the edges of the brick.

90. *Porites* West Indies α . 25. (*P. Americana incertae sedis quinta et vicesima.*)
(Pl. VI. fig. 5.)

[Coll. Poland; British Museum.]

Description.—The corallum is encrusting, and thickens somewhat evenly over the whole surface, so that the centre is but slightly convex, being about 1.3 cm. thick and 10 cm. long by 5 cm. across. It adheres to an old bottle, and is seen under the branching stock in Pl. XV. fig. 4.

The calicles are all flush with the surface and about 2 mm. across, but the outlines are nowhere sharply defined. The walls are remarkable, in that no concentric elements come to the surface, indeed, continuous concentric rings of tissue do not exist. What threads there are, are arranged in sharp, irregular and interrupted zigzags which either interlock or separate adjacent calicles very irregularly (see Table IV. p. 138); seen sideways, the surface skeleton consists of low exsert plates and points. The septa are long, very irregular, bent, slightly nodulated and straggling, continuing the confused strands of the walls into the confused columellar tangle, and but for their traces of radial arrangement, the whole surface skeleton would be one continuous, open, but irregular, angular network. This, indeed, it becomes when the surface is abraded; the calicles are then soon indistinguishable. The order of the fusions of the septa and of the pali is only just traceable, and there is no clearly distinct fossa.

In the section, the skeletal structure is remarkable. It consists of very open fluent reticulum of which the filaments expand frequently into flakes; these flakes are wavy, but largely horizontal. Its trabecular or vertical elements seem to rise up wavelike from these flakes. There seem to be very few sharp angles between the vertical and horizontal elements.

This is the explanate form upon which the branching *P. West Indies* α . 21, rises, see above, p. 97.

Unfortunately, there is no information about its locality. It adheres to an old-fashioned bottle. Its surface has been much abraded, but parts of the original are left. There are several growth edges with their epithecal supports visible round the stock, and at times with the wavy flaky texture of the skeleton exposed. The very remarkable, stout, network appearance of the surface skeleton strongly recalls the appearance of some of the Mediterranean fossil Poritids, and suggests that these latter may have belonged to the Atlantic group and not to the Indo-Pacific region.*

The perfectly superficial character of the calicles apart from the arrangement of the skeleton separates this completely from the astræoid group, although it is an encrusting form (see Introduction, p. 15).

α .

Zool. Dept. 1903. 7. 31. 1.

* It is now very widely believed that the fauna of the West Indies was at one time either directly connected with, or very greatly influenced by, that of the Mediterranean area; cf. Gregory Quart. Journ. Geol. Soc. li. (1895) p. 255.

91. *Porites* West Indies *z.* 26. (*P. Americana incertæ sedis sexta et vicesima.*)

[Les Mers d'Amérique, coll. Lamarck; Paris Museum.]

Syn. *Porites astræoides* Lamarck, Animaux sans Vertèbres, ii. (1816) p. 269.

Under this heading, Lamarck described ("mon cabinet") a large slab of encrusting *Porites* from the American seas, with wavy and gibbous surface, and rough margin, and with calicles said to be small, deep, and close together, the calicle walls being "*lamelloso-striatis denticulatis*."

There is still one very large astræoid *Porites* in the Paris Museum, 30 cm. across the base, and with a label showing it to have belonged to the Lamarck Collection. This may well be the original type. The calicle walls show considerable variations, but are always reticular, the threads being stout; with very short septa, stout and blunt, but occasionally meeting in pairs. No definite arrangement could be made out as to the details of the columellar skeleton.

As already noted in the Introduction, where the subject has been discussed at length, p. 15, almost every encrusting form of *Porites* from the West Indies has been "lumped" with this as all belonging to the same "species." In this volume, we have recognised not only several fundamentally different growth-forms, such as thin and purely creeping, explanate and thickening, and massive, but also the fact that the surface markings show differences referable on a definite principle to their being repetitions of the shape of the early colony.

De Blainville, in 1834,* mentions Lamarck's coral, calling it "*P. astreoites*," and refers to some "fig. 3." His own figure shows the surface of a coral raised into large conical mounds, two of them with Balanids opening near their tips. The calicles further show long radial septa, apparently sloping inwards from the wall edges and not very typical of the corals usually regarded as belonging to the astræoid group.

Milne-Edwards and Haime, in their Monographie des Poritides,† made the species a synonym of the second of Esper's *Madrepora conglomerata* (see p. 114 of this volume), but in 1860 in vol. iii. of Les Coralliaires, Milne-Edwards described *P. astræoides*, quoting the descriptions of Lesueur and Lamarck. The absence of pali is curiously enough not noted, nor the depth of the fossa, and the walls are said to be very thick, coarse, and very echinulate. Indeed, we need not multiply examples of the confusion into which this desire to include all the non-branching *Porites* of the West Indies into one species has led. What is wanted is a new and correct diagnosis of Lamarck's original specimen and a careful comparison of it with other known so-called "astræoid" forms.

In Table III. there will be found a list of such forms already described in this volume from their respective localities. There are three other specimens from unknown localities in the National Collection, and they fall into two kinds, easy to distinguish and to describe. Their descriptions follow on next page.

* Manuel d'Actinologie, p. 395, pl. lxi. figs. 5, 5a.

† Ann. Sci. Nat. (3^e) xvi. (1851) p. 29.

92. *Porites* West Indies α . 27. (*P. Americana incertæ sedis septima et vicesima.*)
(Pl. VI. figs. 6, 7; Pl. XVII. fig. 9.)

[British Museum.]

Description.—The corallum creeps over the surface, the edges running out into lobes. The upper surface is raised sparsely into small, low, round-topped cones, which slope concavely down into broad, flat, shallow valleys. The valleys are filled with minute calicles, so crowded that the walls are incomplete. The tops of the waves have larger, thick-walled calicles, so as to look soft and foaming, contrasting strikingly with the appearance of the valleys.

The calicles vary from 1.5 mm. on the waves to 0.5 mm. in the valleys; they vary also in depth. The walls in the small intercalicular buds on the waves are membranous and lamellate, as they are also in the valleys, in which they are open, ragged, and incomplete lattice-works, with spiky edges. The network of the thicker walls on the wave tips appears loose, open, and filamentous; its lamellate character is almost confined to its vertical elements. The septa are very thin and short, some longer than others, and not betraying any strikingly radial arrangement. The columellar tangle is loose, open, and very irregular, so that some calicles are very deep, while in others, strands of the columella rise up, making the calicle look shallower.

The colour of the unbleached stock is a warmish-brown.

There are two specimens which differ in that the larger and flatter has slightly larger calicles, Pl. VI. fig. 6, but they agree first of all in the character of the eminences on the surface, which differs from any other astræoid *Porites* I have yet seen, and secondly in the character of the calicles. Both of them again are explanate, that is, have creeping edges with less marked growth of the central regions. There are signs also that the museum acquired the two at the same time, which suggests that they were parts of one and the same find, and perhaps from the same locality.

A comparison of this form with that which follows, shows that there is at least as much difference between the two as to justify the most timid of species-makers in giving them different names.

a. A large flat cake.

Zool. Dept. 1906. 1. 1. 11.

b. Irregularly convex, Pl. VI. fig. 7.

Zool. Dept. 1906. 1. 1. 12.

93. *Porites* West Indies α . 28. (*P. Americana incertæ sedis octava et vicesima.*)
(Pl. VI. fig. 8; Pl. XVII. fig. 11.)

[British Museum.]

Description.—The corallum rises into a tall conical mound with rounded top, covered all over with crowds of small mounds, almost of the same shape, and all rising vertically, but

varying greatly in size from 1 to 2 cm. in diameter. These mounds are separated by only narrow convex valleys, that is without any smooth surface between them. The edges of the stock creep down all round, practically to the substratum, unless prevented by the presence of other organisms.

The calicles vary slightly from 1.5 mm. downwards. They all tend to be angular, sharply so in the valleys, less so, that is more subcircular, on the mounds. The wall shows a median line usually broken up into large, smooth, round or angular granules; when these granules run together, we have portions of a wall-thread. The top edges of the septa have the same character, only they run out into short, very sharp points, directed into the calicle aperture. These tops of the septa are sometimes in a ring of their own, distinct from the wall granules; sometimes the two are confused according as the wall is thick or thin. The columellar tangle, owing to the thickness of the elements, is somewhat compact and tends to fill up the base of the fossa at different levels.

The colour of the unbleached stock is an iron-grey. It is very heavy and massive, and built of stout, irregular trabeculae closely packed.

A comparison of this coral, with the one just described, shows that we are dealing with two distinct corals, and that it is the blindest guesswork to assert that they belong to one and the same species. The form here described is not only steeper and has steeper mounds than the one last described, but its elements are strikingly different, as a comparison of the magnified photographs, figs. 7 and 8, Pl. VI. will show at a glance.

a.

Zool. Dept. 1906. 1. 1. 13.

94. *Porites* West Indies x. 29. (*P. Americana incertae sedis nona et vicesima.*)

[Coll. Duchassaing; Turin Museum.]

Syn. *Porites agaricus* Duchassaing and Michelotti, Mém. sur les Cor. des Antilles (1860) p. 83.
(*Neoporites agaricus* in the Suppl. (1864) p. 99.)

Description.—The corallum is like an agaric, explanate, fixed below, but with free edges.

The calicles are very small, about 1 mm. in diameter. The walls are confusedly, because very openly, reticular. The component threads show slight traces of radial or concentric symmetry; when the wall is thin, a short zigzag median thread comes to view. These threads vary in thickness, are angular, bent, and run out into fine points, or swell into finely pointed granules. The septa vary greatly in length, slope inwards from the walls, or as separate radial plates, share the angular ragged character of the wall-threads. They are most symmetrically radial when the walls are most regular. The calicles appear shallow.

This description is based upon the brief remarks made by the original authors and upon a magnified photograph of the calicles of the type specimen in the Turin Museum, kindly supplied for the purpose of this work by Count Peracca (but for technical reasons not reproduced).

It seems to approach nearest in the character of its calicles to *Porites West Indies* x. 15. But the growth there is not agariciform; the calicles are larger, and the wall and calicle skeleton seem to have been more uniformly symmetrical with trabecular tips raised over the surface as separate granules.

It is unfortunate that Duchassaing did not give the exact locality of his specimen.

95. *Porites West Indies* x. 30. (*P. Americana incertæ sedis tricesima*.)
(Pl. VI. fig. 9.)

[“In variis insulis Carabæis,” coll. Duchassaing; Turin Museum.]

Syn. *Neoporites littoralis* Duchassaing, Mém. sur les Cor. des Antilles, Suppl. (1864) p. 99.

Description.—The corallum is encrusting, with wavy or gibbous surface.

The calicles are shallow, variable in diameter up to 1.5 mm. The walls are thick, and built of crisp, much twisted flakes, disposed, for the most part, horizontally, and not very porous. The septa are often ragged points projecting from the edges of the flakes, but sometimes long, straight, very thin, and with lateral points, and fairly symmetrically arranged. A thin, flattened, columellar tubercle is usually to be seen.

This description is again based upon the original text, aided by the magnified photograph of the type in the Turin Museum, kindly supplied by Count Peracca, and reproduced, fig. 9, Pl. VI. Unfortunately we do not know from which one of the several islands of the Antilles, referred to by the authors, this particular specimen comes. It has great interest for us for a comparison with other astræoid forms of *Porites*. There is no other showing the flaky character of the skeleton so strikingly developed except abnormally, see *P. Bahamas* 1, compare also *P. Guadalupe* 6.

96. *Porites West Indies* x. 31. (*P. Americana incertæ sedis prima et tricesima*.)

[British Museum.]

[The specimens are embedded, as fragments of different sizes, in a mass of consolidated raised beach, in which are many fragments of a Madreporid,* great numbers of shells,† echinoid spicules, etc. All the *Porites* fragments are of the same kind, and their characters may be put into a formal description as follows.]

Description.—The corallum was branching with stems from 1.5 to 2 cm. thick, flattening slightly and forking at acute angles.

Calicles, 1.5 mm. across, conspicuous, polygonal, with the wall sharp when the calicles are slightly sunk, or else raised as a thread when the calicles are obsolete. The septa are clear and well developed, though with interrupted edges, either starting from the edge of the

* The Madreporid is solidified throughout.

† Mr. E. A. Smith has kindly given me the following list of recognisable shells, Gastropods—*Natica*, *Cerithium*, *Columbella*, *Turbo*, *Fissurella*; Lamellibranchs—*Mytilus*, *Chlamys* and *Lucina*.

wall, or else first as a septal granule or plate, the septa having a tendency to be lamellate. Here and there fusings of septa take place, but quite irregularly. The pali are also very irregular, appearing only as stray radiating points or plates, with a small, slightly flattened, columellar tubercle.

In the exposed cross-sections of this coral there is a solid layer of nearly 3 mm. thick surrounding a very thick strand of stout, lamellate, streaming layer. The solid cortical layer seems to have been due to subsequent mineralogical changes, because a close examination of it shows stout, rather regular trabeculae and concentric elements here and there still visible.

There are indications, further, that, when alive, the living layer extended only a few centimetres from the tips.

This *Porites* has all the ordinary habits of a West Indian branching form, and, as further Mr. E. A. Smith kindly informs me that the molluscs * indicate the same locality, I have no hesitation in placing this specimen in this group.

a.

Geol. Dept. R. 9820.

Group VIII.—EUROPEAN FOSSIL FORMS.

On turning eastwards from the North Atlantic *Porites* of Bermuda, we look in vain for any recent forms on its eastern shores. The only records are of rich fossil remains of a Poritid fauna which inhabited the Paris and Mediterranean Basins in early and mid-Tertiary times, and the Vienna Basin and the Crimea as early as the deposition of the lower Cretaceous strata. Very few of these, however, appear to have been true *Porites*, although the majority were at first assigned to that genus. The records given in detail in Vol. IV. show how great was the confusion between *Porites* and *Goniopora* (= *Litharæa*). The majority of the forms belong to the latter genus rather than to the former, that is, if the lines of division here adopted prove to be correct.

One of the chief difficulties in the way of the scientific classification of these fossils, lies in the fact that their structural details, which in this genus are especially intricate, are so often obscured. In many cases we have no chance of ever seeing a surface preserved well enough to show the walls and septal formula of the calicle. In most cases we only have sections, and from them, in the normal process of growth, all these surface characters upon which classification depends disappear. It is therefore obvious that no classificatory method, dependent on exact morphological details, such as the method by "specific" or "form" units, is at all possible, for the necessary data are not available, being either absent or blurred by change. On the other hand, let me say that nothing is so dangerously facile as the tossing of these fossils into so many imaginary species, and the extent to which that has been done in the past, renders much of the work hitherto published absolutely valueless. One such wholly imaginary "species," "*P. incrustans*," we shall have to notice in the brief list which follows; we shall call attention, not only to its purely imaginary character, but also to its disastrous effect upon our knowledge of the forms it was thought to help to classify. If some more exact

* See note (†) on page 106.

method of labelling specimens, according to locality, is needed for the recent forms, it is far more necessary, though I admit far more difficult of application, for the fossil. It is more difficult on account of the time element which has to be introduced. What is, however, certain, is that the whole of this European fossil Poritid fauna requires a close study with new descriptions based upon a comparative study of the specimens now preserved in European museums and waiting to be rescued from their specific names.

One point of some importance remains to be noticed. On applying our methods of deciding whether a fossil Poritid is a *Goniopora* or a *Porites*, it is remarkable how completely the views of earlier writers have to be revised. So many, which were at one time thought to be *Porites*, have in this Catalogue to be classed as *Goniopora*. In Vol. IV. there are nearly sixty European fossil *Goniopora*, while in this Volume we have no more than seven *Porites* from the same region, and some of these very doubtful. Whether this lends any support to the view expressed in Vols. IV. and V. that *Porites* is morphologically a derivative of *Goniopora*, by the suppression of the tertiary septa, further research can alone pronounce an opinion. At the same time it must be remembered that this list is far from complete. When the specimens of fossil Poritids, now in different European collections, come to be worked over, one might expect that at least a larger proportion would turn out to be *Porites* than that here given.

The first coral to be mentioned in this group should naturally be that called *Porites panicea* of the Bracklesham beds of Hampshire, described and figured by Lonsdale in Dixon's "Sussex" (1850), p. 156, pl. i. fig. 7. But examination of the original specimen, which is preserved in the Museum, shows that it was what Milne-Edwards and Haime* described it, namely, an explanate *Astræopora*.

97. ?*Porites* Paris Basin 1. (*P. Parisiorum prima*.)

[Auvers, Valmondois, Hauteville (Eocene).]

Syn. *Litharæa heberti* M.-E. & H., Britt. Foss. Corals (1850) p. 39.

Description.—The corallum is said to be a convex mass, frequently built up of superimposed layers.

The calicles are described as 3 mm. in diameter, polygonal, superficial. The walls were hardly distinguishable. The septa, twelve in number, nearly uniform, wedge-shaped, were thick near the walls. They were very perforated, with denticulate edges and with spine-shaped lateral granulations which may meet across the interseptal loculi as synapticulæ. The columella is said to be weakly developed and apparently consisting only of the more internal teeth of the septa.

This is clearly one of the doubtful forms. Its description is entirely from Milne-Edwards and Haime. Its twelve septa seem to fix it as a *Porites*, but their fusion-formula is not given, hence it is impossible to be quite certain; while lastly, the great size of the calicles affords another and very serious element of uncertainty. I know of no *Porites* with calicles so large, yet on the other hand, the twelve septa is a definite character.

A specimen in the Museum which was labelled "*Litharæa heberti*" was described in Vol. IV., p. 138.

* Hist. Nat. des Coralliaires iii. (1860) p. 169.

98. *Porites Paris Basin 2.* (*P. Parisiorum secunda.*)

[Parnes (Eocene).]

Syn. *Porites deshayesiana* Michelin, Icon. (1840-47) p. 164, pl. xlv. figs. 4a, 4b.*Description.*—The corallum was massive ("*Globoso-gibbosa*") and very fragile.

The calicles were small, about 1 mm. or less, "difficult to distinguish out of the spongy reticulum." The walls were thin, thread-like, but crisp and echinulate, and often incomplete. The septa, twelve in number, were wavy, crisp, and frequently meeting an incomplete columellar ring; the interseptal loculi deep and open, the central fossa frequently filled with tissue.

The original figure from which most of these details are taken leaves no doubt as to the specimen being a true *Porites*, and it is surprising that Milne-Edwards and Haime * transferred it to *Litharæa* (as *L. deshayesana*) with its twenty-four septa. In the description given in Les Coralliaires iii. (1860) p. 187, the calicles are said to be from 1.5 to 2 mm., that is, considerably larger than shown in Michelin's figure. As these authors give in addition to Parnes a second locality *Auvert*, they may have had another specimen and have jumped to the conclusion that the two forms belonged to one and the same species.

Reuss † records another form somewhat resembling this coral from the hard limestone of Waschburg near Stockerau, but it is too badly preserved to admit of exact working out.

99. *Porites Bouches-du-Rhone 1.* (*P. Rhodani prima.*)

[Carri-le-Rouet, Bouches-du-Rhone (Miocene).]

Syn. *Porites incrustans* M.-E. & H., Pol. Foss. d. Terr. Pal. (1851) p. 143.*Description.*—The corallum was massive, convex or sublobate.

The calicles were 1.5 mm. or slightly larger, unequal, shallow ("*peu profond*"). The walls were thin, polygonal and denticulate. The septa, twelve in number, were pronounced, thin, ending in two or three small tubercles, a little smaller than the pali. The septa are nearly uniform and usually fuse together in pairs. As a rule, there are five large triangular pali, with one, two or three smaller ones. A small, central, columellar tubercle was present.

This description certainly seems to refer to a true *Porites*, and we may gather, with some probability of being correct, that it came from the locality above mentioned. So much is simple and clear, and such a simple fact would have been useful for all time, but the gratuitous additions envelop it at once in confusion.

The coral was thought to belong to the species "*incrustans*" of Defrance. As far as I can

* Pol. Foss. d. Terr. Pal. (1851) p. 143.

† Naturwiss. Abh. von Haidinger, ii. (1848) p. 29.

gather, there is no record of this species at all. It does not exist. DeFrance's original specimen he called *Astræa incrustans*. But I have failed to find any description of this original. Let us then overlook all that and start again with Milne-Edwards' species *Porites incrustans*, the original of which we may now regard as this specimen from the Mouth of the Rhone. We should again have something definite except for the indefiniteness of the "species" founded upon it. It has loomed too large as a species. So important was this "species" that it was stated by Milne-Edwards and Haime to include that established by Michelin and called *P. collegniana*. Not only was there no evidence for this, but Michelin's coral was a *Goniopora* with more than twelve septa.

Again, as usual, such a species has been made to include fossil specimens from all parts. In fact, almost every encrusting *Porites* has been placed automatically into the species *P. incrustans*. For instance, in 1864, Martin Duncan* claimed to have recognised this "species" at Kurrachee (see Vol. V. p. 232), and used the discovery as part of the cumulative evidence that the stratum was Miocene. What is especially unfortunate is that such "identifications" render descriptions and figures unnecessary. Reuss, for instance, recorded in 1871 fossil *Porites* from fourteen localities in the extensive Miocene beds of Austro-Hungary. The greater number were simply called *P. incrustans* Defr. Only one of them did he illustrate, and his figure shows the specimen to have been a *Goniopora*.†

When all these imaginary relationships are swept away, we have the simple facts above detailed left; even then there is the danger that the original description was not that of a single specimen, but was built up of characters supplied by several, with perhaps one or two details borrowed from Michelin's description and figure. If so, this coral must be re-discovered and re-described.

100. *Porites* *Alessandria* 1. (*P. Alessandrina prima*.)

[Stazzano, near Novi-Alessandria (Upper Miocene, "Tortonian"), coll. Michelotti;
Geological Museum, Rome.]

Description.—The corallum forms smooth, thick stems (2 cm. thick), cylindrical or slightly compressed.

The calicles are quite superficial, 1.5 mm. in diameter. The walls, built of thin, horizontal flakes, not very porous, but with bends and slight folds. The twelve septa often seem as if they were embossed upon the surface of the flakes; except for slight angular points, they are smooth and show clear traces of the typical septal formula in which the fusion is complete. The points of fusion sometimes end free, sometimes abut against a ring. They do not swell into pali, and the columellar tubercle is conspicuous.

This is a true *Porites* and differs from all others so far recorded. The fact that the skeletal elements are formed mainly of flat flakes parallel with the surface, is a familiar adaptation in recent forms (Tables IV., Vols. V. and VI.). The presence of the typical septal formula establishes beyond doubt the true position of this form.

* Ann. and Mag. Nat. Hist. xiii. (1864) p. 305.

† See Vol. IV. p. 124.

101. *Porites Alessandria 2.* (*P. Alessandrina secunda.*)

[Stazzano, near Novi-Alessandria Piedmont (Tortonian), coll. Michelotti; Geological Museum, University, Rome.]

Description.—The corallum rose into irregular, angular spikes, on columns some 3 cm. in thickness.

The calicles were 1 mm. in diameter and crowded. The walls were either single, interrupted threads, or a reticulum, consisting seldom of more than one row of meshes. The septa are twelve and show the typical formula, the directive triplet being often only partially complete. They are thick, short, and with a tendency to swell into paliform knobs, in which case a columellar tubercle may rise corresponding in thickness with the rest of the skeletal elements; or again, the septa may fuse into an open columellar ring. The skeleton is everywhere composed of thick, smooth trabeculæ and threads; the meshes, though sharp and distinct, are small. The trabeculæ, in vertical section, are slightly nodulated, radiate outwards, in compact parallel bundles, with only small, irregular openings between.

This is a typical *Porites*; the method of growth can be gathered from its shape and especially from the fracture which shows a central region, from which the calicles start upwards and outwards to different lengths. No original surface which is absolutely above suspicion can be made out; it is, consequently, impossible to say whether the calicles were superficial or depressed.

I have been permitted to examine the original specimen by the courtesy of Prof. Portes. I have failed to find any other *Porites* very similar to it. It is quite different from the other *Porites* from the same place described above as *P. Alessandria 1*.

102. *Porites Turin 1.* (*P. Taurinina prima.*)

[Turin (Middle Miocene); "and at Tortona (Upper Miocene)"].

Syn. "*Litharæa diversiformis* Mich.," Sismonda Palæontologie du Piémont (1871) p. 25, pl. ix. figs. 1, 2.

Description.—The corallum was massive, irregularly humpy, or lobate.

The calicles averaged 1 mm. in diameter, depressed, "but not so deep as they are broad," polygonal. The twelve septa were not very crowded, though thick, and they showed hardly any difference between primaries or secondaries.

The columella was spongy.

From the figures, which are quite clear, we gather that the walls are thin, sharp and

straight (i.e. not wavy); that the septa, whose edges are granulated, occasionally meet; that pali were represented; and that the interseptal loculi were large, open and well developed between the straight septa.

This seems to be a true *Porites* in spite of the fact that the figure shows fifteen septa. The description states that there were twelve.

Group IX.—FORMS FROM NO RECORDED LOCALITY.

In Group VII. (p. 80) descriptions were given of *Porites* as to which there was good reason to believe, either from their structural details or from their labels, that they were from the West Indian and Atlantic region. But in this group will be found those which show no such satisfactory sign. Indeed, as far as I can yet judge, the majority of them have the appearance of belonging to the Indo-Pacific area. A few doubtful cases are, however, noted.

103. *Porites* z. 1. (*P. incertæ sedis prima.*)

Syn. *P. arenosa* Esper, Fortsetzung, i. (1797) p. 80, pl. lxxv.

Description.—The corallum is encrusting, as a thin, smooth, explanate stock, with edges hardly 4 mm. thick.

The calices are ill-defined, slightly sunk, with loose, open, reticular walls, "the meshes taking almost more room than the solid matter." The interseptal loculi run back freely into the reticular walls. The septa are represented by rows of sand-like granules. The pali are scattered and not arranged in any distinct ring. The columellar tubercle is occasionally present.

The unbleached stock is a pale yellow-ochre.

This description and Esper's figure embody all that we know about this *Porites*. On the other hand, the amount which has been written about the "species" *arenosa*, and the number of quite different *Porites* which have been identified with it is positively ludicrous. As a specimen it represented a solid fact. As a "species" it has been a trap into which almost every student of the *Porites* has fallen. I believe that in every collection of any size in Europe, one or more *Porites*, often very unlike one another, will be found labelled *arenosa*. In the first draft of this Catalogue I attempted to give some account of the way it has imposed upon worker after worker, and I penned several pages in an attempt to unravel the confusion; but in this revision I decided to state the bare fact alone, cautioning all students for the future to ignore the so-called "species" and confine himself simply to ascertainable fact.

104. *Porites* α . 2. (*Porites incertæ sedis secunda*.)

Syn. *Madrepora porites* Esper, Pflanzenth. i. (1789)* p. 135, pl. xxi.

Description.—The corallum rises into tall, open, branching stocks. The stems are of smooth, wavy outline of uneven thickness. The forking is irregular, but where most abundant it is roughly dichotomous, at varying distances apart, and at very sharp angles which, however, usually curve outwards so that the prongs diverge. Prior to forking the stems show pear-like swellings with slight indentations to mark the beginning of division. The living layer extends over the whole stock, some 14 cm. in height.

The calicles appear from the original figure to have one very striking characteristic, viz. the conspicuous rings of pali. The artist shows the whole surface granular, and the calicles indicated by raised groups of pali with a columellar tubercle in the centre of each. The intervening walls appear flat.

The cross-section is shown with indications of conspicuous radial trabeculae surrounding a small axial strand, and it may be noted that such trabeculae would be in keeping with the surface granules and pali.

The colour is a yellowish brown.

The locality of this form is given merely as the East Indian seas. Branching forms are known, e.g. from Tonga Islands (Vol. V. p. 39), but they are certainly not as characteristic of the Indo-Pacific region as they are of the West Indies. There ought to be no difficulty in recognising the form again, with its remarkable development of pali and its swollen pear-like terminals.

105. *Porites* α . 3. (*Porites incertæ sedis tertia*.)

Syn. *Madrepora porites* var. β Esper, Pflanzenth. i. (1789)* p. 135, pl. xxia.

Description.—The corallum sends up from an extended base a crowd of tapering spikes, from 6 to 8 cm. long, and of varying thicknesses from 2.5 to 1 cm., some smooth and simple, others forking quite irregularly, the prongs curving away in different directions, without order or symmetry of any kind.

The calicles are quite irregular in a finely granular surface.

The colour of the unbleached stock is nearly black, and penetrates 5 mm. into the coral.

This singular *Porites* was also, like the last, said to have come from the East Indian Seas, and that is probably correct. Its peculiar growth ought certainly to enable us to recognise it again, as soon as its home is located.

* I am indebted for this date to Mr. Wm. Sherborn.

106. *Porites* z. 4. (*Porites incertæ sedis quarta.*)

Syn. *Madrepora contigua* Esper, Pflanzenth. Forts. i. p. 81, pl. lxvi.

Description.—The corallum rises in small irregular tufts of erect crumpled leaves, or greatly compressed stems, 4 cm. high. The top edges are lobate, and bent, the lobes separated by incisions of various lengths. Knobs or lobes also project from the faces and sides of the leaves.

The calicles are hardly visible to the naked eye. The whole surface is covered with granules or flakes, partly simple, partly echinulate, all reaching the same height. Here and there a rounded fossa with a central tubercle can be recognised, while round these the granules are arranged radially.

The surface is white.

This description is based upon Esper's text and figures. There can, I think, be no doubt whatever that it was a true *Porites* with a smooth, granular surface and superficial calicles. The septa, as stellate arrangements of granules, surround a fossa with a central tubercle, no pali being differentiated. Lamarck identified this coral with one from the Indian Ocean which he called "*Pavonia plicata*" (= *Psammocora contigua* M.-E. and H.), but I do not see how the identification of these figures with *Psammocora* is possible. The magnified figure shows the granules scattered confusedly over the surface, but nothing approaching the patterns typically seen on *Psammocora*.

I have seen no *Porites* either in London or Paris at all resembling this. It remains to be re-discovered, which should be easy considering its remarkable character.

107. *Porites* z. 5. (*Porites incertæ sedis quinta.*)

Syn. *Madrepora conglomerata* Esper, Pflanzenth. Forts. i. p. 72, pl. lix.

Description.—The corallum is globular with flattened base, but with only a small area of attachment to the substratum; round this area edges of different growth-periods can be made out. The lateral and upper surfaces are so convoluted as to appear almost broken up into separate lobes between which deep concave valleys dip down.

The calicles are not described or figured. We gather only that they are typical of the Poritidæ, but whether of *Goniopora* or of *Porites*, there is no means of knowing. They are said to be very like those of the coral figured on Esper's pl. lix, which appears from the fact that it had fifteen septa to have been a *Goniopora*.* From the general character of the specimen as figured, it is fairly safe to regard it as having been a true *Porites*.

Esper obtained the specimen from a friend, who again had it from an old collection, but

* See below, p. 157.

though absolutely nothing is known about it, except what can be gathered from Esper's figure, it has been regarded as the type of a "*species*," and many have been the *Porites* from almost all parts of the world which have been claimed as representatives of it.

We may note that Brüggemann* mentioned that the name "*conglomerata*" rightly belonged to the specimen figured by Esper on pl. lix. That controversy may now surely be considered dead.

108. *Porites* *z.* 6. (*Porites incertæ sedis sexta.*) (Pl. XVI. fig. 2.)

[Coll. Lamarck ; Paris Museum.]

Syn. *Porites conglomerata* var. 2 Lamarck, Anim. sans Vert. ii. (1816) p. 269.

Description.—The corallum appears to be a small branching tuft. The branches stand out in all directions from a thickened central stem, and divide, at angles of about 90°, into short, thick, flat-topped terminals. The living layer is about 3 cm. deep.

The calicles are small, 0·8 mm. in diameter, and depressed. The walls appear thick, the wall-thread being coarse and further enlarged by the septa, which are coarse, short, thick, truncated, close together, and irregular. The five principal pali are mostly large, angular and smooth, and sometimes joined by fine threads to the septa.

The sections of the branches are very dense, showing only a few very thick threads free.

This is a very old specimen (No. Z 187*j* in the Paris Museum) and with the next, is of considerable historical interest, for they are the "*var. 2*" and "*var. 3*" respectively of Lamarck's *Porites conglomerata*, as can be seen by old labels still found attached to them.

Lamarck's line of thought can fortunately still be made out. He followed Esper, who put together as *Madrepora conglomerata*, two specimens which he figured (Fortsetzung i. pl. lix. and pl. lixa). The former is a branching Poritid, here placed among the *Goniopora*, see p. 157, and the latter a distorted glomerate mass which was doubtless a *Porites*. Lamarck accepted the existence of a species called *Porites conglomerata*, of which this latter coral of Esper's was the type. Encouraged by Esper having classed a branching form with it as a variety, Lamarck did the same, but gave two varieties showing a series, for his var. 2 "*nana ; ramulis brevissimis lobatis subcapitatis*" leads on to his var. 3 "*ramosa subdichotoma*." The latter he believed to be synonymous with Esper's branching form figured on pl. lix. above referred to. From this time on, the confusion caused by this quite imaginary "species" became more and more bewildering. It may for the future be buried: the only kernels of fact worth preserving are the details we can get from the figures and the specimens.

With regard, then, to the specimen we are here discussing, we have the few facts above detailed: we know where the type is to be seen, and as for its locality, we know nothing for certain but that its method of growth suggests its possibly being a West Indian form.

* Abh. Bremen, v. (1878) p. 546.

109. *Porites* x. 7. (*Porites incertæ sedis septima.*) (Pl. XV. fig. 1.)

[Coll. Lamarck; Paris Museum.]

Syn. *Porites conglomerata* var. 3 Lamarck, Anim. sans Vert. ii. (1816) p. 269.

Description.—The corallum rises as a low solid group of short thick stems, either springing from the surface of an explanate base or else with a common base arising from the confluence of the bases of the separate stems. These latter are 2 cm. thick, and about 4 cm. long. Their tops divide irregularly so that short thick terminals radiate from them in all directions, often compressed and curving. The living layer is 7 cm. deep.

The calicles are 1.25 mm. in diameter, angular and superficial; on the flattened tops of many of the thicker terminals they open in an undifferentiated reticulum. The walls are thin and raised just enough to trace a fine polygonal network over the surface. The septal granules are conspicuous as a ring between the wall and the pali, but are not seldom joined to the wall. There are usually 6 to 7 pali, as prominent granules, with a columellar tubercle. The whole surface seems to be uniformly covered with granules.

This is the substance of the rather brief descriptive notes made on specimen Z 187 *d* in the Paris Museum. Attached to the specimen is a very old parchment label, which showed that it was the "*Porites conglomerata* var. 3" of Lamarck. In Milne-Edwards and Haime's *Monographie des Poritides* (1851), as also in *Les Coralliaires* iii. (1860), one of these varieties of Lamarck's *conglomerata* was placed as a synonym of *P. clavaria*. The confusion is certainly very great, but I remember quite satisfying myself that this was the variety so treated by Milne-Edwards and Haime.

As to the locality, once more we have a branching form far more suggestive of a West Indian than of an Indo-Pacific home.

110. *Porites* x. 8. (*Porites incertæ sedis octava.*)

[? Fiji Islands, coll. Wilkes Expedition, 1838-42; ?]

Syn. *Porites cylindrica* Dana, Zooph. (1848) p. 559, pl. liv. fig. 4.

Description.—The corallum forms compact bundles of long, wavy, neatly cylindrical stems, 12 to 16 mm. thick, which fork at very small angles and at long intervals. The terminals with rounded tips may be 2.5 cm. long and 8 mm. thick. Living layer, 2.5 to 5 cm. deep; stocks 15 to 20 cm. high.

Calicles superficial, quite indistinct.

This is one of Dana's types, probably from the Fiji Islands. There is no known Fiji form with which it can at present be associated.

Other branching forms are known in which the superficial calicles are quite obscure in the surface texture. One striking example is *P. Great Barrier Reef 12*, see Vol. V. p. 118.

Some notice ought here to be taken of a coral which has caused a great deal of confusion. I refer to the small encrusting *Porites* from no certain locality belonging to the Berlin Museum, and called by Ehrenberg *P. punctata*. This was seen by Milne-Edwards and Haime, and made into a new genus *Stylarcea Mülleri*, but later these same authors changed it back to Ehrenberg's original name. Dr. Klunzinger recognised it, as well as Ehrenberg's *Porites arenacea*, as being the same as certain forms which he had found in the Red Sea. Passing over all the confusions of names we have the simple facts just related; see the remarks in Vol. V. p. 243.

111. *Porites* z. 9. (*Porites incertæ sedis nona.*) (Pl. VII. fig. 1.)

[British Museum.]

Description.—The corallum forms small, thin, encrusting patches which follow the unevenness of the substratum. The margin, sometimes free, is about 0.5 mm. thick, closely supported by an epitheca.

The calicles are ill-defined as faint depressions in an otherwise smooth, soft-looking surface. Their radial symmetry is only seen by looking vertically downwards into the narrow interseptal loculi. They are 1 mm. in diameter. The walls are quite flat without median ridges, and consist of so much reticulate tissue deeply and irregularly incised by the interseptal loculi which sometimes communicate with those of adjoining calicles.

The septa are thick, with granulated or finely echinulated sides, and regularly meet and fuse in four pairs and one triplet in the typical manner. The apices of these triangular groups of septa reach nearly to the centre and are slightly enlarged as pali, which as such are not distinguishable. An irregular columellar tubercle fills up the minute fossa.

There are two small colonies of this *Porites*, one about 3.5 to 4 cm. across, and the other about 1 cm. The larger one is on the stem of a *Mussa*, while the smaller lurks between its calicles.

The absence in this *Porites* of any clearly defined wall, the long interseptal loculi, the obscurity of the pali, and the presence of the minute tubercle filling up the fossa, give this coral a resemblance to a *Psammocora*. But close observation shows (1) that there are frequently small areas of delicate mural reticulum between the calicular areas as marked by the septa; (2) that the septa meet and fuse in the typical manner for *Porites*, no such fusion being known in *Psammocora*. The fact that Dr. Klunzinger made the same comparison for his *Porites echinulata*, see *P. Red Sea 7*, Vol. V. p. 241, which also grew on the branches of older corals, suggested the possibility of this being specifically identical, but Dr. Klunzinger's photograph shows an entirely different calicular structure.

There is unfortunately no recorded locality, nor do the characters either of the *Porites* itself or of the immense *Mussa* which it encrusts give us any clue to its home.

a. Two small patches on a *Mussa*.

Zool. Dept. 1906. 1. 1. 14.

112. *Porites* z. 10. (*Porites incertæ sedis decima.*) (Pl. VII. fig. 2; Pl. XVII. fig. 12.)

[British Museum.]

Description.—The corallum grows out into flat, horizontal, dish-like leaves, free for 20 cm. and more, and supported to the edge by epitheca; they are 1 mm. thick at the growing edge, 11 to 12 mm. near the attachment of the old stock. The living layer extends some 10 cm. inwards from the edge; the central part within the living layer in large stocks is dead and often partly arched over by fresh layers. About 1 cm. from the free margin, concentric rows of cœnenchymatous pustules make the surface uneven. These are submerged as the coral thickens.

The calicles are superficial, very ill-defined, about 1 mm. near the margin, but to the naked eye extremely minute, as irregular breaks in the smooth granular surface. The smooth flat cœnenchyma (= fused walls) is covered with tall, slightly branching granules, rather wide apart and giving the surface a dusty appearance. Beneath these granules the texture is composed of flat flakes. The calicles are rendered visible chiefly by the grouping of the septa, which differ from the surface granules only in size and arrangement and may be here and there very slightly exsert. They are completely united in four pairs and a triplet in the typical manner, and the five pali or exsert inner edges of the septa are frequently V-shaped. The septal granules are very irregularly developed; in the younger calicles occasionally they may unite with the pali, but in the older calicles the granules of the walls and the pali are joined by a ring of septal granules. The central fossa is a mere pin-hole, in which a minute columellar tubercle may be just visible. The cœnenchymatous pustules have a texture slightly different from that of the level surface; there are no granules and the surface is reticular, but smooth, dense, and with microscopical pores. Calicles open on the larger of these elevations.

Foliate *Porites* have not been hitherto known, and this is the most pronounced of the forms now discovered. On its method of growth-form, see p. 137.

In Table III. Vol. V. and on p. 259, a list of all the foliate *Porites* so far recorded is given with their localities. This one, which is by far the most remarkable of all, not only in its growth-form but also for its other structural features, has unfortunately no recorded locality. It is a cœnenchymatous *Porites*. Under the older system it would have been classed as a *Synaræa*, see Vol. V. pp. 9 and 274.

On the dead part of this coral is a young specimen as a small hemispherical colony, consisting of a central larger parent calicle (0.75 mm. across) and a ring of five smaller daughters. The calicles all gape open, and the septa, hardly traceable down the sides, yet stand up round the edge on the top of the wall, very irregularly, but apparently in two cycles. One of the most interesting features is the presence of pronounced directives in some of the daughters, and these directives are in vertical planes, radially symmetrical with septa or costæ of the parent.

While it is probable that any young colony of *Porites* found round the base of a large stock is an offshoot of that stock, it is often quite impossible to say from any structural features whether this is the case or not. There is abundance of evidence that stocks only gradually

acquire their typical calicles, apparently only with their typical growth-forms. Hence the relationship of young colonies can only be decided either by direct observation or by the discovery of a series of stages.

a. Large specimen with very young colony.

Zool. Dept. 99. 3. 2. 8.

113. *Porites* *x.* 11. (*Porites incertæ sedis undecima.*) (Pl. VII. fig. 3.)

[British Museum.]

Description.—The corallum is explanate, encrusting and varying in thickness from 2 to 6 mm. with curled up edges. Fresh layers creep over previous growths not always in close contact. The complete form is unknown.

The calicles with undefined outlines, distinguishable only by the central fossa which may open flush with the surface or at the bottom of a faint depression. The walls are broad and flat, and covered with an even layer of star-like or very jagged granules, which are fairly uniform in size and distance apart. They appear to be the echinulate tips and edges of otherwise smooth erect flakes. The septa are not visible under these granules, nor are they indicated round the mouth of the fossa by any pronounced radial arrangements of the latter, although what are apparently interseptal loculi radiate outwards irregularly from the fossa and bend away among the open spaces between the granules. Close round the fossa the granules are sometimes slightly larger than elsewhere, but they seldom form any traceable ring of pali. When, however, this occurs, the usual palic formula can be made out, though incomplete. A distinct columellar tubercle is also sometimes present, at others the fossa is a deep round hole. The texture revealed in vertical section is very open, being built up of thin, regular, vertical trabeculae rather far apart, with thin, regular, horizontal junctions. The rich, warm, buff colour extends about 1 mm. below the surface.

This coral is represented only by a fragment. From the specimens with which I found it associated in the collection, I judge it to have been a Pacific Island form, and one of Mr. Gardiner's collection (? from Funafuti). As a mere fragment without definite locality, it would have been hardly worth keeping, but its characters are so far unique. There is nothing I can recall like its rich development of beautiful surface granules obscuring the calicular skeleton.

a.

Zool. Dept. 1906. 1. 1. 15.

114. *Porites* *x.* 12. (*Porites incertæ sedis duodecima.*) (Pl. VII. fig. 4.)

[British Museum.]

Description.—The corallum is a small, smooth, irregular, cap-shaped growth, encrusting previous layers; the creeping edges bending under, enveloping, and binding together a mass of sand and small shells.

The calicles appear minute and ill-defined to the naked eye, being flush with the surface or faintly depressed; they are slightly under 1 mm. in diameter. The walls are thick, flat, or very slightly convex, solid, without median ridge, but strewn with loose, shapeless granules. The calicle skeleton, which nearly fills the fossa, consists of an outer ring of septal granules, and an inner ring of pali which are all large, regular, and compact, and so finely frosted as to appear smooth and well-defined. The directive pali are frequently found in the outer ring. The inner pali ring usually shows four well developed lateral principals. The central tubercle is often also well developed and sometimes flattened. Here and there a few of the septal granules are joined to the solid wall, in which case the septa are thick and wedge-shaped, and the interseptal loculi, in such places, run back a little into the wall. No traces of septa other than the septal granules or of columellar tangle can be seen below the level of the granules, which so completely fill the calicle. The pali ring never rises as a central boss.

The colour of the unbleached stock was a dull buff.

This small specimen with no recorded locality was originally labelled *Synarœa informis* by Brüggemann. The reason for this identification can be seen by comparing the calicles with Dana's figure of the calicles of his *Porites informis* (Zooph. pl. lv. fig. 6 *b*), where the thick walls with the scattered granules are well shown; but that is the only likeness. Neither the outer ring of septal granules nor the central tubercle occur in Dana's coral, and the method of growth is very different.

This *Porites* is typical of the Indo-Pacific region, but we unfortunately can come no nearer to its haunt. The creeping method of growth, forming a small irregular cap over a conglomeration of other dead organisms, apart from its very regular calicles and nearly solid wall built of close layers of irregular flakes, are characters which differentiate it from all the other creeping forms in the collection.

a.

Zool. Dept. 55. 12. 27. 48.

115. *Porites* z. 13. (*Porites incertæ sedis tertiadecima.*)

(Pl. VII. fig. 5; Pl. XVII. fig. 13.)

[British Museum.]

Description.—The corallum forms globular masses perched on narrow bases or stalks. The surface is covered with convolutions which tend to have median, longitudinal ridges, especially on the top of the stock; at the sides they may be rounder; the dividing valleys vary greatly in depth, every now and then sinking into angular pits; the edges closely encrusting and creeping under the stock.

The calicles are about 1 mm. across, deep, alveolar, the walls being tall, excessively thin, membranous and fenestrated, with delicate, slightly denticulate edges. The septa only appear deep down as very short, thin projections, meeting frequently in pairs, and sending up from the points of junction thin pali. These surround a very large and deep fossa. Here and there the walls become delicately reticular in the angles, and new calicles develop, so that young shallower calicles occur scattered over the surface. Round the base all the parts thicken, but

the only change in structure is that the walls are much lower, and have lost their delicate membranous character.

The coral is of a cold, dull grey colour.

The two specimens differ in minor details, but the chief characteristics, the raised walls, and the convoluted surface they have in common. In *b* the convolutions are less marked than in *a*, and the walls are not so thin and delicate.

These are clearly Indo-Pacific forms, and may have formed part of Mr. J. J. Lister's collection from the Tonga Islands, the bulk of which was described in Vol. V. pp. 34 to 41.

a. With very thin, high walls.

Zool. Dept. 1906. 1. 1. 16.

b.

Zool. Dept. 1906. 1. 1. 17.

116. *Porites* *z.* 14. (*Porites incertæ sedis quartadecima.*) (Pl. VII. fig. 6.)

[British Museum.]

Description.—The corallum rises as a flat-topped, pear-shaped mass, with rather smooth surface, and closely encrusting edges extending downwards 5 cm.

The calicles are composed of open, delicate reticulum, about 1.25 mm. across. The walls are mostly raised as a thin, nearly straight thread, sometimes quite smooth and conspicuous, at others, broken up into minute spiky granules. Within the wall there is a ring of septal granules joined by delicate, glassy synapticulæ, the septa being also delicate threads. The pali are normal, and rise as slightly longer, spiky or frosted granules. They all rise from an open, reticular, thread-like tangle, from which a small, often flattened, columellar tubercle also rises. The openings between the delicate skeletal elements are large, enabling one to look down into the coral.

The section shows a very compact arrangement of fine, glassy, uneven trabeculæ, which rise as a dense forest of small spiky or frosted granules.

The figure is taken from the flat top of the stock, where the growth is purely reticular and not trabecular. On this account there are no granules. The specimen almost certainly belongs to the group *P. Tonga Islands* 4 to 7 (see Vol. V., pp. 36–38). The characters are especially interesting here in contrast with those of the West Indian forms.

a.

Zool. Dept. 1906. 1. 1. 18.

117. *Porites* *z.* 15. (*Porites incertæ sedis quintadecima.*) (Pl. VII. fig. 7.)

[British Museum.]

Description.—The corallum is glomerate, with convoluted surface; the ridges being low and flat-topped, or slightly ridged, separated by shallow, irregular valleys. The living layer is confined to the top of the mass, extending only 2 to 3 cm. down the sides.

The calicles are all slightly pitted, so that the walls trace a low network over the surface. They vary in size, averaging 1 mm. They open in a delicate, filamentous reticulum. The

walls are variable in thickness; where thinnest, they appear as a delicate, but pronounced zigzag, elsewhere this is thickened by the septal granules and synapticulæ. These wall elements are all slightly thickened, and contrast with the very delicate threads of the inner ends of the septa and columellar tangle. The ring of pali is often complete, and stands up as a conspicuous boss in the centre of the calicle; seen sideways, the oval ring appears to consist of four thick, lateral pali, the rest being thin, delicate, and rod-like. The columellar tubercle is conspicuous, frequently flattened and extended across the calicle, as its median or directive plane.

The colour is dull grey, and its section shows an almost dense arrangement of long, fine irregularly nodulated trabeculæ.

This coral compares in many respects with *Porites* x. 13, and appears to have belonged to the same collection. The differences between them are most instructive, and as long as the calicles are our chief guide we must keep them apart. We may later find some means of analysing the structural features in a way which will enable us to recognise what are mere accidental variations in calicle formation, and what are fundamental.

a.

Zool. Dept. 1906. 1. 1. 19.

118. *Porites* x. 16. (*Porites incertæ sedis sextadecima.*) (Pl. VII. fig. 8.)

[British Museum.]

Description.—The corallum forms a massive irregular crest, which rises with a colony of worm-tubes incorporated in its substance and opening over its surface. The mouths of the tubes mostly bend over so as to lie on the surface of the coral, seldom looking outwards like the calicles.

The calicles are angular, depressed, 1.5 mm. in diameter. The walls are thin, mostly with a whitish edge as if of powdered glass. The septa are short, thin, and granular as they project from the walls some way below their upper edges. The pali are rather large, rough granules, generally visibly associated with the primaries. The central tubercle is also rough and granular, and often plate-like. On the lower parts of the coral the edges of the septa may stand as granules away from the wall, and the intra-calicular skeleton may then appear to consist of large granules not very crowded, and not reaching to the top of the wall.

The colour is a pale buff, and the granules are either glassy, or whitish and powdery.

There is only one specimen. It is impossible to say what the special character of the calicles is, or whether its growth with worm-tubes is accidental, or a normal case of symbiosis. Unfortunately no locality has been recorded which might act as a guide. While I regard it as Indo-Pacific, I should find it hard to give any very definite reason for the opinion. There is no other course open than to describe and figure it in hopes of its nearest allies being some day discovered.

a.

Zool. Dept. 1906. 1. 1. 20.

PORITES OF THE ATLANTIC AND WEST INDIAN REGION.

ANALYTICAL TABLES OF THE RESULTS WITH OBSERVATIONS.

[N.B.—The positions in these Tables of any of the forms above described can be found by consulting the Index.]

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5	<i>Brazil 1</i> , Recife do Lixo, Abrolhos, and Porto Seguro.	Yale Coll. Mus.	29
6	<i>Brazil 2</i> , Parahybo do Norte, and Candeias Reef, Pernambuco.	Proc. U.S. Nat. Mus. x. (1887) pl. xix. fig. 2.	Washington Mus.	29
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7	<i>Curaçoa 1</i>	Seba, <i>Thes.</i> (1758) pl. cix. fig. 11; also Pl. XVII. fig. 3. ? . . .	30
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10	<i>Trinidad 1</i> , Savannah Grande	Eocene	Pl. I. figs. 5a, 5b	Brit. Mus.	33
11	<i>Barbados 1</i>	Dana's Zoophytes (1848) pl. liii. fig. 6.	Washington Mus.	34
12	<i>Barbados 2</i>	Pl. I. fig. 8; Pl. XV. fig. 5	Brit. Mus.	34
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15	<i>Barbados 5</i>	Pleistocene	Brit. Mus.	37
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17	<i>Barbados 7</i>	Pleistocene	Pl. IX. fig. 2	Brit. Mus.	39
18	<i>Barbados 8</i> , Low level reef, near Bridgetown.	Pl. IX. fig. 3	Brit. Mus.	40
19	<i>Barbados 9</i> , High level reef, Castle Grant, and summit of Mount Misery, St. Thomas Parish.	Pleistocene	Brit. Mus.	41
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26	Guadalupe 6	Pl. II. figs. 2, 3	Turin Mus.	45
27	Antigua 1, Packam Sound Reef	Pl. II. fig. 4; Pl. X. fig. 1	Brit. Mus.	46
28	Antigua 2	Pl. II. fig. 5; Pl. X. fig. 4	Brit. Mus.	47
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30	Antigua 4	Pl. II. fig. 7; Pl. XVII. fig. 4	Brit. Mus.	48
31	Barbuda 1	Pl. II. fig. 8; Pl. X. fig. 3	Brit. Mus.	49
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39	St. Thomas 1	Cor. des Antilles, Suppl. (1864) pl. x. fig. 13.	? Turin Mus.	56
40	St. Thomas 2	Pl. XI. fig. 1	Paris Mus.	57
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42	St. Thomas 4	Pl. III. fig. 5; Cor. des Antilles, Suppl. pl. x. fig. 14.	Turin Mus.	58
43	St. Thomas 5	Pl. III. figs. 6, 7a, 7b; Pl. XVII. fig. 6.	Turin and Brit. Mus.	59
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46	Porto Rico 1	Pl. XI. fig. 3	Paris Mus.	61
47	Porto Rico 2, off Culebra, Point Mula Lighthouse.	15½ fathoms, coral sand.	U.S. Fish Com. ii. (1900) pl. ii. figs. 4, 4a, 4b.	Washington and Brit. Mus.	62
48	Porto Rico 3, Culebra, Ensenada Honda.	U.S. Fish Com. ii. (1900) pl. xxix. and pl. xxxi. fig. 2.	U.S. Nat. Mus.	63
49	Porto Rico 4, Culebra, Ensenada Honda.	U.S. Fish Com. ii. (1900) pl. xxx. and pl. xxxi. fig. 1.	U.S. Nat. Mus.	64
50	Porto Rico 5	U.S. Fish Com. ii. (1900) pl. xxxii. and pl. xxxiii. fig. 1.	U.S. Nat. Mus.	65
51	Porto Rico 6	U.S. Fish Com. ii. (1900) pl. xxxiii. and pl. xxxiv. fig. 2.	U.S. Nat. Mus.	66
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57	<i>Florida 2</i> , Reefs	Pl. III. fig. 8; Mem. Mus. Comp. Zool. vii. i. (1880) pl. xii. figs. 4, 5, 6.	Brit. Mus.	72
58	<i>Florida 3</i> , Reefs	Mem. Mus. Comp. Zool. pl. xvi. figs. 13-20.	Washington Mus.	73
59	<i>Florida 4</i> , Reefs	Mem. Mus. Comp. Zool. pl. xii. fig. 7.	Washington Mus.	73
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92	<i>West Indies x. 27</i>	Pl. VI. figs. 6, 7; Pl. XVII. fig. 9	Brit. Mus.	104
93	<i>West Indies x. 28</i>	Pl. VI. fig. 8; Pl. XVII. fig. 11 .	Brit. Mus.	104
94	<i>West Indies x. 29</i>	Turin Mus.	105
95	<i>West Indies x. 30</i>	Pl. VI. fig. 9	Turin Mus.	106
96	<i>West Indies x. 31</i>	Brit. Mus.	106
VIII. European Fossil Forms.						
97	<i>Paris Basin 1, Hauteville.</i>	Eocene ? . .	108
98	<i>Paris Basin 2, Parnes.</i>	Michelin, Icon. (1843-47) pl. xlv. figs. 4a, 4b.	. . ? . .	109
99	<i>Bouches-du-Rhone 1, Carri-le-Rouet</i>	Miocene ? . .	109
100	<i>Alessandria 1, Stazzano</i>	Upper Miocene, "Tortonian."	Geological Mus., Rome.	110
101	<i>Alessandria 2, Stazzano</i>	Tortonian	Geological Mus., Rome.	111
102	<i>Turin 1</i>	Middle Miocene	Sismonda, Palæont. Pied. (1871) pl. ix. figs. 1, 2.	. . ? . .	111

SUPPLEMENTARY.

The following (Group IX. of this closing Volume on the Poritidæ) is a list of *Porites* from no recorded locality, some of which undoubtedly belong to the Indo-Pacific area, while others might belong to either that or to the Atlantic or West Indian. The list is thus supplementary to Table I., Vol. V. p. 248, as well as to that just concluded.

NO.	DESIGNATION AND LOCALITY	DEPTH	HORIZON	REFERENCE TO PUBLISHED FIGURES	MUSEUM IN WHICH THE ORIGINAL SPECIMEN IS PRESERVED.	PAGE
	IX. Forms from no recorded locality.					
103	<i>Porites</i> x. 1. . . . .	. . . . .	. . . . .	Esper, Fortsetzung, i. (1797) pl. lxxv.	. . ? . .	112
104	<i>Porites</i> x. 2. . . . .	. . . . .	. . . . .	Esper, Pflanzenth. i. (1789) pl. xxi.	. . ? . .	113
105	<i>Porites</i> x. 3. . . . .	. . . . .	. . . . .	Esper, Pflanzenth. i. pl. xxia.	. . ? . .	113
106	<i>Porites</i> x. 4. . . . .	. . . . .	. . . . .	Esper, Fortsetzung, i. pl. lxxvi.	. . ? . .	114
107	<i>Porites</i> x. 5. . . . .	. . . . .	. . . . .	Esper, Fortsetzung, i. pl. lixa.	. . ? . .	114
108	<i>Porites</i> x. 6. . . . .	. . . . .	. . . . .	Pl. XVI. fig. 2	Paris Mus.	115
109	<i>Porites</i> x. 7. . . . .	. . . . .	. . . . .	Pl. XV. fig. 1	Paris Mus.	116
110	<i>Porites</i> x. 8. . . . .	. . . . .	. . . . .	Dana, Zoophytes (1848) pl. liv. fig. 4.	. . ? . .	116
111	<i>Porites</i> x. 9. . . . .	. . . . .	. . . . .	Pl. VII. fig. 1	Brit. Mus.	117
112	<i>Porites</i> x. 10 . . . . .	. . . . .	. . . . .	Pl. VII. fig. 2; Pl. XVII. fig. 12	Brit. Mus.	118
113	<i>Porites</i> x. 11, ?Funafuti . . . . .	. . . . .	. . . . .	Pl. VII. fig. 3	Brit. Mus.	119
114	<i>Porites</i> x. 12 . . . . .	. . . . .	. . . . .	Pl. VII. fig. 4	Brit. Mus.	119
115	<i>Porites</i> x. 13, ?Tonga Islands . . . . .	. . . . .	. . . . .	Pl. VII. fig. 5; Pl. XVII. fig. 13	Brit. Mus.	120
116	<i>Porites</i> x. 14, ?Tonga Islands . . . . .	. . . . .	. . . . .	Pl. VII. fig. 6	Brit. Mus.	121
117	<i>Porites</i> x. 15, ?Tonga Islands . . . . .	. . . . .	. . . . .	Pl. VII. fig. 7	Brit. Mus.	121
118	<i>Porites</i> x. 16 . . . . .	. . . . .	. . . . .	Pl. VII. fig. 8	Brit. Mus.	122

While this Volume is going through the press, Dr. T. Wayland Vaughan informs me by letter that fresh collections enable him to increase the number of apparently distinct Laysan and Sandwich Island *Porites* from 12 to 34 (see Vol. V., pp. 97 to 106).

TABLE II.—SUMMARY OF THE GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF THE PORITES HERE RECORDED FROM THE ATLANTIC, THE WEST INDIES, AND FROM THE EUROPEAN TERTIARY BEDS.

	DISTRICT.	FOSSIL, WITH HORIZON WHEN KNOWN.	RECENT.	TOTAL NUMBER.
Atlantic, West Indies and Gulf of Mexico.	West Africa and Cape Verde Islands . . . . .	. . . . .	4	4
	Brazil . . . . .	. . . . .	2	2
	West Indies (known localities)	1 Eocene and 6 Pleistocene	39	46
	West Indies (unknown localities) . . . . .	. . . . .	31	31
	Florida and Florida Reefs . .	1 Miocene	5	6
	Bahamas and Bermuda . .	. . . . .	4	4
European Fossils.	Paris Basin	1 Eocene ; 1 ?	. . .	2
	Mediterranean Basin . . .	4 Miocene	. . .	4
	Totals	14 Fossils	85 recent	99

TABLE III.—ANALYSIS AND DISTRIBUTION OF THE KNOWN VARIATIONS
IN GROWTH-FORMS OF THE PORITES OF THESE SAME REGIONS.

SINCE the preparation of the analytical table on the growth-forms of the Indo-Pacific *Porites* in Vol. V., and even since the printing of the systematic description in this Volume, some further insight has been gained as to the general principles of growth in the Stony Corals—see for details, Introduction, Sections III. and IV. We nevertheless still start from the same ideal initial colony, a small plano-convex disk, for from it all the later forms may be deduced, not as we assumed in Volumes IV. and V. by direct continued growth, but by a succession of repetitions. The initial colony appears to grow continuously to a certain size, and during this growth it assumes some definable shape of its own. Its further growth as an individual is then apparently arrested, and by means of some asexual reproductive process not yet understood, the colony repeats itself and a new colony appears upon the old.

The shapes assumed by the initial colony may be roughly divided into two: those which grow mainly in width and those which grow in height. All those which grow in width necessarily build massive stocks by the repetitions of their colonies, each new colony covering over and killing the one from which it sprang. The new colonies of those which grow in height on the other hand need not necessarily each time kill the parent, at least as far as we can see. Although, if they did, we should therein find a reason for the phenomenon that many tall forms have the growing colony confined merely to their tips. Hitherto, it has usually been customary to refer this to the crowding of the stems. But while that is a good cause in many cases, it will not always apply.

In all former tables we have taken the shape of the whole stock alone into consideration: it is clear that now in all future classifications of growth-form, we shall have to find the shape of the colonial units of which each stock is composed. It is these, one would think, which should supply us with our basis of classification. So little, however, is yet known of them and of the degrees to which they may be specialised and disguised, that we propose to continue in the old paths, merely calling attention to any clear cases of metamerism which we see. In the future, however, there can be no doubt that the metamerism factor in stockbuilding will have a definite place in systematic descriptions. I say a definite place, because it has already unconsciously forced itself upon the notice of systematists, e.g., in such cases as those in which a massive form is obviously built up of successive layers, and is variously described as massive, and as encrusting, according as the mind of the student is most attracted by the mass or by the successive layers of which it is built.

It must indeed be admitted that it is even now difficult to decide how such forms should be classified. At present we can do no better than take the form of the stock, rather than of the individual segments.

A. *Plano-Convex.*

This ideal primitive colony, which plays such a large part in building up the stocks of *Goniopora*, has, as already noted in Vol. V., p. 258, not persisted so frequently in *Porites*. One explanation of this may be that simple undifferentiated *Porites* colonies would be much smaller than those of *Goniopora*, and therefore have escaped the vigilance of collectors. Stocks

built up of series of such colonies are naturally numerous, but they pass with massive forms, and we meet at the outset with the difficulty mentioned above—are we to classify according to the form of the initial colony or by the stocks which they build up? If, for example, we find a small plano-convex colony, how are we to know whether it is an adult stock or merely the initial segment of a stock? With these doubts kept well in mind, we find the following West Indian and Atlantic forms showing, either in their complete forms or in their initial colony units, this simple character.

- P. West Africa 1.* Grows in small flat convex patches apparently on mud.
- P. Anguilla 2.* The small stock is nearly plano-convex and it appears to be built of colonial units of that shape.
- P. Santa Cruz 1.* Perhaps only a young stage.
- P. St. Thomas 5.* Entangled with branching forms, but may be regarded as built of plano-convex colonies (? belongs to B, c).
- P. St. Thomas 6.* "Placentiform," with edges partly free (? belongs to B, c).
- P. West Indies x. 15.* Rolled round the stem of a Gorgonid.

N.B.—It may be that the characters of the calicles might enable us to say whether the individual plano-convex colony was destined to form a massive or an explanate adult. This appeared to be the case in the genus *Goniopora*. Shallow calicles are characteristic of explanate forms, and deep calicles of massive forms.

B. *Explanate.*

The same remarks hold good again here. Are massive forms which are obviously built up of piles of thin layers to be classified as thin explanate or as massive? We propose to mention them under both headings, but at the same time we note that *Porites* whose initial colony units are thin layers, need not necessarily build massive stocks. They may build loose crusts, or, again, if the lateral growth is very vigorous, the successive growths may start into being at the edges and not in the centre of the parent colony. In this way we obtain expanding disk-like growths dying away in the centre. This kind is seen, for instance, when the original colony grows out laterally from a side like the basin of a drinking-fountain (see below for an example *Porites x. 10*, p. 137).

a. Thin, encrusting.

- P. Cape Verde Islands 2.* Forms, by successive thin layers, a small cushion-shaped mass.
- P. Guadalupe 3.* Apparently creeping over the ground.
- P. Barbuda 3.* A small cushion-shaped mass, built of thin layers.
- P. West Indies x. 25.* A thin layer built up of several thinner layers.

b. Thin, with free edges.

- P. Antigua 4.* Thin layers build up an agaric-shaped mass (? belongs to C).
- P. West Indies x. 29.* (= "*Neoporites Agaricus*," D. and M.).

c. Thick, encrusting.

- P. Cape Verde Islands 1.* With stout spreading lobate edges.
- P. Brazil 2.* Closely encrusting, and with convex surface (? A).

- P. St. Thomas 7.* Creeping (?).
P. Bahamas 1. With thin edges, which sometimes thicken rapidly.
P. West Indies x. 26. Lamarck's original "*P. astræoides*."
P. West Indies x. 27. With segmentation disguised.
P. West Indies x. 30. (= "*Neoporites littoralis*," D. and M.).

C. Massive.

We have already noted the very natural confusion which has attended the use of this term. In those cases in which the consecutive growths are very distinct and show great numbers of edges, there has been a tendency to speak of it as "encrusting," because its construction out of a pile of layers is apparent. While those forms in which the consecutive growths droop so as to cover the edges of previous layers are called massive, it seems clear that if we wish to call attention to the differences in our choice of names, such terms as massive and encrusting are not calculated in any way to express what we wish to emphasise. Both forms are massive, and what we want to express is that the growth segments of the one are pronounced and of the other disguised. This disguising is most complete when the corallum is a globular mass, each growth completely enveloping the whole. Such a form appears to have grown from the first as a single homogeneous mass, and further, the first glance of its section shows the same, an expanding bundle of continuous trabeculæ. But a comparative study of growth processes shows that this is only an extreme specialisation; it cannot be regarded as any exception to the rule of growth of the Stony Corals, even if no tabulæ could be found, but tabulæ are found, and tell the same tale as bands of epitheca round edges, for these two features are parts of one and the same structure.*

- P. Brazil 1,* = the "*P. solida*" of Verrill, described as "encrusting" or "massive!"
P. Trinidad 1. Only known in fossil fragments.
P. Barbados 9. " "
P. Guadalupe 6, compared with "*P. conglomerata*" Esper† and with surface raised into round lobes.
P. Antigua 4. Segmentation obvious (see above B, b).
P. Porto Rico 5. Segmentation disguised, a typical specimen of "*Astræoides*" *autorum*.
P. Porto Rico 6. " " "
P. St. Domingo 1. " " "
P. Belize 2. " " "
P. Belize 3. " " "
P. Florida 6. " " "
P. West Indies x. 28 " " "
P. West Indies x. 29 " " "

As already pointed out in the text p. 15, these "*Porites astræoides*," that is those massive, or thick encrusting forms in which the growth segments are disguised—cannot justly be regarded as one and the same species, because differences appear which seem to be fundamental. I refer

* The case of *P. China Sea 14* (Vol. V. p. 177), is worth recalling. There were apparently two specimens, one thin encrusting, and the other a huge mass built up of piles of such stocks. I was at the time much puzzled as to the description of its growth-form.

† Pflanzenth. Suppl. i. pl. 59A. (See above, p. 114.)

to the eminences on their surfaces. These seem to be controlled by some definite law which we express by saying that there is a tendency for the eminences to repeat the form of the stock. This shows at least that the differences are not purely accidental and therefore negligible, and that our investigations have to be greatly extended before we are in a position to make any definite statements as to their physiological relationships.

D. Columnar.

I am not certain whether there is any true columnar growth-form among these Atlantic and West Indian *Porites*. The following may, however, be provisionally placed under this heading:—

P. St. Thomas 1. The thick stems of this slowly branching form suggest its being placed here.

P. West Indies x. 12. This again, the "*P. macrocephala*," D. and M., may be provisionally placed here.

P. Alessandria 2 (?)

E. Branching.

In this Volume we have figured some forty-four branching Atlantic and West Indian forms, and these, with figures published elsewhere, give us a list of close upon sixty growth-forms to be compared and grouped. We have already noted that the usual group names, *clavaria*, *furcata*, and *divaricata*, refer only to the character of the branching, and are far too crude and insufficient even for that purpose alone,* to say nothing of the many other characters which such a method utterly ignores. But while it is easy to say what method of classifying will not do, it is by no means easy to sketch a method which is much more satisfactory than those we reject. After many attempts we fall back upon the metameric growth principle especially prominent in these many branching *Porites*. We can classify by the characters of the colonial units, so far as we can recognise them as sections forming the stock almost as links form a chain.

It will be noted that this does not depart far from our previous method of referring all growth-forms back to an ideal initial plano-convex colony which grew up centrally to form columnar and branching stocks. The difference between the methods is, however, obvious. Under this earlier method the subsequent growth was, as it were, uncontrolled by any known principle; now we know at least that some principle of repetition guides the growth. This is so far helpful that it enables us to picture to ourselves somewhat more sharply and precisely the initial colony of each growth, and to lay down a provisional classification according to what we judge to have been its most striking characters. Every one who has tried to classify corals will find this a considerable relief, because many specimens seem to start from broken fragments or overturned specimens. Hitherto there has been no possibility of knowing what was the normal form of the stock. We of course know of individual cases of overturned Madreporae and Turbinarias, which at once repeated their normal forms from the bases or sides of the overturned stocks, indeed from any part so long as it was uppermost. But these few cases hardly seemed sufficient to justify our assuming that any stock growing in this way returned instantly to its normal method. It is a gain therefore, to have, for the future, a good reason for believing this always to be the case.

* This insufficiency has already been felt by Dr. Wayland Vaughan as related, p. 11.

We begin our series, then, from an initial stock, which best carries on the series begun by the explanate and massive forms. That would be one, from the surface of which there arose in the centre or round the edges, more than one eminence or lobe. Such lobes would grow on and fork, and eventually form a tuft of short thick branches; several perhaps rise from one and the same base.

It is not necessary to repeat here what was said above, see p. 18, on the origin and formation of knee-bends. It has, however, to be kept in mind in all analyses of the growth-forms.

a. With thick encrusting base from which more than one branching lobe arises.

P. Curaçoa 1. The original figure (reproduced, Pl. XVII., fig. 1), suggests that the branches grew from the edges of a thick encrusting base. The perspective of the figure, however, may be wrong. The regular repetition of the forking suggests a more normal start.

P. West Indies x. 15 (Pl. XVII. fig. 20, γ). As this form grows round a Gorgonid skeleton, it is difficult to say whether it is a normal growth or not.

P. West Indies x. 24 (Pl. XVII. fig. 10). On the problems relating to its growth-form, see text, p. 101.

The following forms may belong here or to the next group. The cause of the doubt is that small stout lobes or branches may perhaps fuse together to form a solid mass, which is not the true original base, yet looks like it. This problem of fusion deserves special study for we shall find it occurring at one time as if it were normal, while at another the branches seem to go out of their way to avoid it. In the following cases, though the short branches toss about in all directions, they do not show sufficient signs of fusing to justify our concluding that their bases are due to fusions.

P. Antigua 1 (Pl. X. fig. 1). This stock having grown upon the side of an overturned earlier stock looks in the figure as if it belonged to this group, but see next page, c; ii. a.

P. Barbuda 1 (Pl. X. fig. 3). The fact that this coral seems also to start from more than a single lobe of a massive base, serves as another link to unite it with *P. West Indies* x. 24.

P. Bermuda 1 (Pl. XII. fig. 4). There are more signs of fusion in this specimen. Yet a close examination of it suggests its having started from a stout ridge-like basal form which broke up into short lobes, three to four in number.

P. West Indies x. 11 (Pl. XV. fig. 2). This again looks as if it might have started as an irregularly bluntly angular ridge, which gradually divided into elongating and forking angular processes, every one of which retains the flattened appearance of the ridge.

Porites x. 7 (Pl. XV. fig. 1). I provisionally place this in this group. It has all the appearance of being a massive base, from which branching lobes spring up; and further, it has much more the character of a West Indian, than of an Indo-Pacific, form.

b. Single short thick knobs or lobes rise, and divide, and form somewhat massive tufts with only slight traces of free branching. In other words, the forkings of the lobes follow one another very rapidly and at very short distances apart.

P. Guadalupe 5 (Pl. XVI. fig. 6). The lobes are short and thick, but there is some irregularity in the distances between the forkings, and the stock rises chiefly in height.

P. West Indies x. 10 (Pl. XIV. fig. 3). This is a small rounded tuft, apparently complete, but perhaps distorted by Balanids.

P. West Indies x. 22 (Pl. XVI. fig. 5). This also forms an irregular tuft of short, thick, irregularly forking lobes.

P. West Indies x. 23 (Pl. XV. fig. 3). The forking is like the irregular dividing of the lobes of a ridge.

Porites x. 6 (Pl. XVI. fig. 2). A rather more open tuft (placed here provisionally as possibly a West Indian form).

c. Stock rises as a single stout stem which branches more freely.

i. With more or less pronounced tapering of the stocks upwards.

P. Antigua 2 (Pl. X. fig. 4). With dichotomous forking at open angles, prongs straight and tapering.

P. Bermuda 2 (Pl. XII. fig. 3). Short thick stems with thick but tapering prongs.

P. Bermuda 3

P. West Indies x. 17 (Pl. XVI. fig. 3). With thinner and longer prongs.

P. West Indies x. 21 (Pl. XV. fig. 4). Young form, very short and squat, rapidly tapering to small mammillate prongs.

ii. With no regular tapering or thinning down, but on the contrary, prongs may be irregularly swollen into knobs, or flattened, without, however, any increase in the average thickness of the stems and branches.

a. The branches and prongs all tending to bend in toward the axis.

P. Antigua 1 (Pl. X. fig. 1). The original single stem of the overturned stock is seen on the right hand side of the picture, see for description, text, p. 46. The stems show irregularities in thickness and in the forms of the prongs, some swollen, some pointed. The branchlets of the overturned stock have bent up somewhat towards the light.

P. Curaçoa 3 (Pl. IX. fig. 6). A small tuft with branchlets swollen, and the stems bending upwards towards the light.

P. St. Thomas 2 (Pl. XI. fig. 1). The stems are thick, crowded, regular forkings at wide angles, and at short distances.

P. Porto Rico 1 (Pl. XI. fig. 3). The stems are thin, long, swelling irregularly, and with strong tendency to bend inwards.

P. Florida 2. See text, p. 72.

P. West Indies x. 2 (Pl. XIII. fig. 1). The stems are thick, and fork very freely, but at comparatively short distances, so as to produce a tangle. Branchlets often long, thick, and fusiform.

P. West Indies x. 3 (Pl. XII. fig. 1). The stems are long and tend to curve inwards towards the axis. Forking at quite irregular distances, sometimes far apart, resulting in long, stout, finger-shaped branchlets, at others so close as almost to suggest that the branchlet divided into more than two.

P. West Indies x. 14 (Pl. XIII. fig. 3). On this interesting young form, see text, p. 90.

β. The stems and prongs diverging in all directions.

- P. Curaçoa* 1 (Pl. XVII. fig. 3). The branchlets are much bent and expand freely in all directions.
- P. Barbados* 2 (Pl. XV. fig. 5). A young form forking at very wide angles.
- P. Barbados* 3 (Pl. IX. fig. 5). The branchlets are stout and somewhat sparse.
- P. Antigua* 3 (Pl. X. fig. 7). The branchlets are stout, almost nodulated, with irregular forking.
- P. Barbuda* 2 (Pl. X. fig. 6). Small fragments only.
- P. Anguilla* 1 (Pl. X. fig. 5). " " "
- P. Belize* 1 (Pl. IX. fig. 1). Stems seem to rise from an overturned tangle.
- P. Florida* 5 (Pl. XI. fig. 2). The stems are long, crooked, and with sparse forking.
- P. Porto Rico* 4. A compact mass of long, wavy, almost serpentine stems; serpentine owing to the succession of their knee-bends, the clustering being so close that prongs are frequently aborted. (Cf. Pl. XIV. fig. 1, for a form in the Paris museum, which differs in all details, but shows a somewhat similar growth-form expanding from one initial colony.)

Doubtful forms.

- P. Barbados* 6 (Pl. IX. fig. 4). The prongs are aborted into small spur-like processes, while the stems grow into long tapering points, but the form of the stock is unknown.
- P. Barbados* 7 and 8 (Pl. IX. figs. 2 and 3). Only known in fragments.

d. Forms, the initial colony of which rises pear-shaped upon a narrow stalk, with or without a small disk-like base. Upon the division of this swelling colony into two, fresh colonies grow, also swelling, with the result that the stems tend to thicken irregularly as they rise. If the thickening is gradual the stems may remain nearly vertical; if considerable, then the upper surface of the stock must expand to make room for the swollen tips of the stems.

- P. Curaçoa* 2. The stock expands rapidly as a thick cluster rising on a narrow stalk.
- ? *P. Barbados* 4 (Pl. IX. fig. 6). A fragment only.
- ? *P. Barbados* 10. A minute pear-shaped stock. ? An initial colony.
- P. Guadalupe* 4 (Pl. XI. fig. 5). A cluster of thick round-topped stems, radiating from a small base.
- P. St. Thomas* 3 (Pl. XI. fig. 4). This specimen is so squat that it is more massive or columnar than branching. The lobes swell into great rounded masses.
- P. Porto Rico* 3. (See Table I., p. 125, for reference to the original figure.) Stout erect stems, gradually thickening, and with well-rounded tops.
- ? *P. Florida* 1 (Pl. XII. fig. 2). See text, p. 71.
- ? *P. West Indies* x. 4 (Pl. XIII. fig. 4). With a tendency to form flabellate clusters.
- ? *P. West Indies* x. 5 (Pl. XIII. fig. 5). The same, only unique in ending in sharp points.
- P. West Indies* x. 8 (Pl. XIII. fig. 2). A fragment showing two prongs with flattening and dividing tips; the flattened tips have sharp edges.
- P. West Indies* x. 9 (Pl. XIV. fig. 2). The tips thicken (? chiefly flatten), expand and divide so rapidly and irregularly that the stock grows out laterally over a thin stalk.

- P. West Indies x. 13* (Pl. XIV. fig. 4). Tends to form massive flabellate base, with fringe of tall erect branches of irregular thickness, which fork again, so as to form fresh flabellate bases.
- P. West Indies x. 18* (Pl. XIV. fig. 5). The tips swell and divide into rounded knobs very irregularly; stems keep as nearly as possible erect.
- P. West Indies x. 19* (Pl. XVI. fig. 1). A dense cluster of irregular stems with knob-like tips; stock expands into an inverted cone, upon a thin basal stem.
- P. West Indies x. 20* (Pl. X. fig. 2). Thin, short, wavy, nearly erect stems, flattening and swelling irregularly.

APPENDIX TO TABLE III.

On the Growth-Form of Porites x. 10.

Among the *Porites* from unknown localities, there is one growth-form which demands special notice, viz., that of *Porites x. 10* (see Pl. XII. fig. 2, and Pl. XVII. fig. 12). It is quite unique in the genus so far as our personal knowledge goes. It is a very pronounced cœnenchymatous form showing some cœnenchymatous papillæ, like a papillate *Montipora*. This, I think, definitely establishes it as an Indo-Pacific form, for the cœnenchymatous *Porites* are so far unknown in the Atlantic and West Indian area. It appears to have grown out from the side of some object as a large irregularly ear-shaped dish, shallow with very thin delicate edges and about 12 mm. thick where it was attached. In order to bring this into line as a product of a metameric series of colonial units, we have to conceive of the series as a pack of cards lying horizontally on one another, with a certain number superposed directly upon one another, thereby thickening the lateral attachment, while above this the successive growths are pushed further and further outwards, so as to form the dish or cup described. This was not all, for we can gather two other important points: (1) the new growths start from the edges, that is the highest point, and grow backwards, often perhaps arching over the old stock; and (2) this kind of growth shows us that the successive growths have some general average size, as we should expect them to have if our supposition that they are metameric repetitions is correct. For the new growth upon the edge tends sooner or later to break up into lobes, as if no single colonial unit is large enough to cover the whole edge, after, in the expansion of the cup, it has exceeded a certain size.

TABLE IV.—ANALYSIS AND DISTRIBUTION OF THE MORE EASILY DEFINABLE TYPES OF CALICLE.

As already explained in the Introduction, the calicles of these West Indian *Porites* differ in general habit from those of the Indo-Pacific area. We have traced the difference (see Introduction, p. 13) to the fact that the skeletal elements are all coarser and thicker in the *Porites* of the former area than in those of the latter. This difference has a somewhat remarkable effect, for the size of the calicles remaining about the same, the extra thickness robs the skeleton of its plasticity; its patterns are stiffer and rougher, and there is consequently less delicacy, regularity, and symmetry than is the rule with the calicles of the Indo-Pacific forms. As an illustration, compare the first figure on Plate I., which belongs to the Indo-Pacific group, with those immediately following it, which are all of Atlantic specimens.

Taking a glance at the calicles as seen in the Plates I.–VI., it is at first sight difficult to find any character which seems to have stability enough to supply us with any taxonomic character. We have therefore to fall back upon the method of classification adopted in the Table III. in Vol. V., p. 258. This was based upon the number of rings of trabeculæ round the central tubercle, because, however irregular, they could be counted in all cases except those in which the whole skeleton was melted down into a confused network; and, further, they clearly referred to characters of prime morphological importance.*

The innermost ring is that of the pali which are generally well but irregularly developed in all the Atlantic and West Indian forms except in what is known as the astræoid group; the chief characteristic of this latter group being the large open fossa with only scant traces of pali deep down (see below, p. 142).

The second ring is that of the septal granules, which are very variously developed and indeed chiefly recognisable in a long comparative survey. They are but seldom mentioned in the systematic descriptions because they are in themselves so unobtrusive, yet when the whole series is compared in the way here proposed according to the rings of trabeculæ, they become of great importance. This was exactly our experience in Vol. V.

The third ring is that of the wall granules or trabeculæ, and are marked w^1 in the Diagram (B)— w^2 being the wall granule of an adjacent calicle in all these forms with simple zigzag walls. In Vol. V. p. 273, some doubt was expressed as to whether the thickness of this zigzag—not as a line but as a system—might not just as well indicate the depth to which the calicles were interlocked as the distances they were apart as units of the colony. The confusion of the skeleton is often so great that the exact relationships are frequently impossible to make out, but in all cases in which among these West Indian forms the elements are clear, the wall granules always belong to the same septum as the septal granules. This leaves no doubt that the thickness, or rather the depth, of the zigzag represents the distance between the calicles.

The fourth ring is but very seldom developed in these West Indian *Porites*. For even where their walls are reticular, the reticulum is mostly due to the fact that a separate ring of tissue unites the *septal granules* producing the condition which Gardiner has called Trinurate (see Vol. V. p. 16). The condition with a fourth ring, does however just occasionally occur (see below).

The fifth and higher rings which occur in great abundance among the Indo-Pacific forms

* On the morphological importance of trabeculæ in this genus, see Vol. V. p. 272.

(= the coenenchymatous forms or *Synaræa* of authors), are not yet known among the West Indian *Porites*. They indicate, as already explained in Vol. V. p. 15, looser colonies, that is, stocks in which the calicles are wide enough apart to allow costal elements to appear. Whether the absence of these can be correlated in any way with the other difference pointed out between the *Porites* of the two regions, remains to be seen.

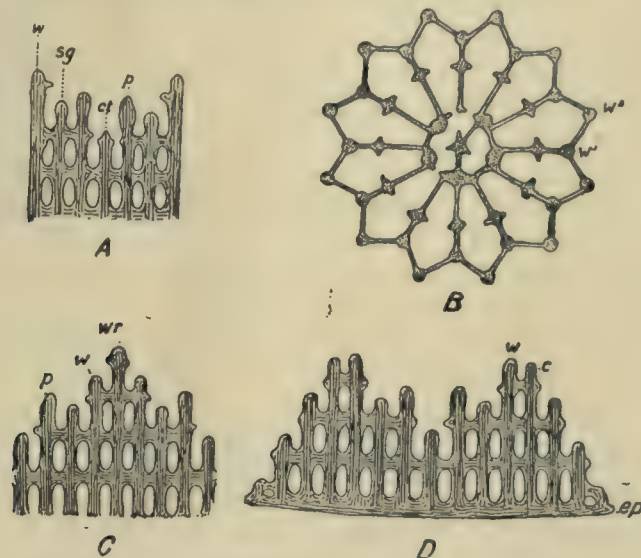


FIG. 1.—Diagrams illustrating the structure of the theca of *Porites*. A, an ideal vertical section through a simple walled calicle of a colony; *w*, the wall trabecula; *sg*, the septal granule; *p*, the palus; *ct*, the central tubercle (these three are seen, like *w*, to be the tips of trabeculae). B, a horizontal section of a calicle in a colony in which the thecae are slightly separated so that the synapticulae joining the wall trabeculae (*w*¹) with those of adjacent calicles (*w*²) have a zigzag course. C, a vertical section through a compound wall, which appears when the simple walls (*w*) are far enough apart to admit of an intervening trabecula, in this case figured as rising above the walls (*w*) as a wall-ridge (*wr*), making *w* look like another granule of the septal edge (the “wall granule”). D, an ideal parent calicle to explain the origin of intervening trabeculae; they are homologous with costal trabeculae (*c*), one or more of which are able to appear if the calicles in a colony are far enough apart to admit them; *ep*, epithecal saucer or prototheca.

A. Forms whose calicles have traces of more than three rings of trabeculae.

P. Cape Verde Islands 2 (Pl. II. fig. 3). Among the thicker walls some appear to have more than three rings.

P. Bahamas 1 (Pl. IV. figs. 2, 3, 4, 5, 6). The walls here vary much in thickness, and it is only in the thicker parts that the extra trabeculae can be assumed, for the tendency to become purely reticular obscures the actual details.

P. West Indies x. 15 (Pl. V. fig. 3). The walls are here thickened throughout; the calicles are unique among the West Indian forms, in that the trabeculae as seen at the surface are graduated in thickness from the pali which are normal outwards on to the wall where they are thick, though see *P. Cape Verde Islands 2* above. The variation in the thickness of the walls is very great.

The above are the only known *Porites* from these regions which approach the coenenchymatous forms so common in the Indo-Pacific area, see Vol. V., Table III. And with regard to these it is a matter of doubt whether, except in the case of *P. West Indies* x. 15, the thick walled calicles are quite normal; compare for example the observations on *P. Bahamas* 1.

B. Forms with three rings of trabeculæ. The wall ring is always a zigzag, more or less pronounced.

- P. Cape Verde Islands* 1 (Pl. I. fig. 2). The wall and septal granules sometimes touching, and sometimes distinct. This condition may indicate irregular perforations in the septa.
- P. Cape Verde Islands* 3 (Pl. I. fig. 4). The wall and septal trabeculæ quite distinct—exact conditions, however, disguised by the irregularity of the skeleton.
- P. Curaçoa* 2. See text, p. 31.
- P. Barbados* 2 (Pl. I. fig. 8), with the wall and septal granules distinct, the latter tend to be united into a ring.
- P. Barbados* 3 (Pl. I. fig. 9). The wall and septal granules distinct where the elements are thin, but the two become confused when the elements are thick and run together.
- P. Antigua* 1 (Pl. II. fig. 4). The wall and septal granules very close together.
- P. Antigua* 2 (Pl. II. fig. 5), with the wall trabeculæ raised so as to make a thin castellated ring round the calicle. The intracalicular skeleton somewhat confused.
- P. Antigua* 3 (Pl. II. fig. 6). The wall and septal granules frequently united into small petaloid flakes. The zigzag wall-thread frequently very thin.
- P. Barbuda* 1 (Pl. II. fig. 8). The septal granules distinct, wherever skeleton is not all melted together (? by post-mortem aqueous corrosion).
- P. Anguilla* 1 (Pl. III. fig. 2). The wall and septal trabeculæ fairly distinct, but the calicle is very small, and the skeletal elements are thick and coarse; the details are only discoverable with a lens.
- P. St. Thomas* 3 (Pl. III. fig. 4). The skeleton is open, with finely echinulate elements. The trabeculæ are only just indicated by slight thickenings in the tracery. It appears as if the septal granules and the wall granules were distinct, though the details are confused by irregular echinulation.
- P. St. Thomas* 4 (Pl. III. fig. 5). The three rings complete and distinct in larger calicles, but irregular and confused in the smaller.
- P. Florida* 2 (Pl. III. fig. 8). The three circles distinct, the septal trabeculæ and the wall trabeculæ distinct, elements often smooth and sharply defined.
- P. Florida* 5 (Pl. III. fig. 9). The three circles distinct, but elements coarse, thick, and irregular.
- P. Bermuda* 1 (Pl. IV. fig. 7). The skeleton here open, there with the walls and the septal granules tending to run into horizontal flakes.
- P. Bermuda* 2 (Pl. IV. fig. 8). The points where the trabeculæ come to the surface confused by echinulation, so that the smooth surface of wall and septal edges which look like narrow flakes have saw-like edges. From the sizes of the calicles and the length of the septa, we may conclude that the three circles are complete and distinct.

- P. Bermuda* 3 (Pl. IV. fig. 9). The three rings appear to be complete but the skeleton is coarse and very confused.
- P. West Indies* x. 13 (Pl. V. fig. 1). The skeleton is open and very perforate, hence the surface is much broken up, but septal granules can be made out distinct from the wall granules, and about equidistant from the pali as from the latter.
- P. West Indies* x. 14 (Pl. V. fig. 2). The wall is zigzag, and raised irregularly; the septal granules are like knobs at the ends of short stalks projecting from the angles of the zigzag; the internal skeleton variously developed.
- P. West Indies* x. 16 (Pl. V. fig. 4). The septal granules are complete but very close to the walls.
- P. West Indies* x. 18 (Pl. V. fig. 7). The skeleton is open; the tops of the trabeculae are like granules over the whole surface; the three rings very clear; the pali very distinct.
- P. West Indies* x. 19 (Pl. V. fig. 8). The skeleton is open, with elements all rather thin and perforated, so that at the surface the intracalicular skeleton is broken into separate points; the septal granules thus often form a ring distinct from the wall.
- P. West Indies* x. 20 (Pl. V. fig. 9). The symmetry is somewhat obscured by a tendency to melt down into a network.
- P. West Indies* x. 21 (Pl. VI. fig. 1). Extraordinary variations in the thickness of the elements, following no patterns, but groups of elements of great thickness run in streaks across, and independent of the calicle areas, so that parts of walls, septa and individual pali may be exceptionally stout, while the elements adjoining these patches may be very thin; the septal granules are distinct from walls, and at times even on long wavy stalks.
- P. West Indies* x. 22 (Pl. VI. fig. 2). The septal granules as very small knobs symmetrically arranged just within the slightly raised zigzag wall.
- P. West Indies* x. 23 (Pl. VI. fig. 3). The septal granules seem at the surface as if broken up into long granulated masses.
- P. West Indies* x. 24 (Pl. VI. fig. 4). The septal granules are here like granulated masses on the wall, there distinct and as if tending to form a ring; the wall thread being here very thick, there very thin. The pali are sometimes joined into a stout ring.
- P. West Indies* x. 25 (Pl. VI. fig. 5). The skeleton is open; the elements smooth, filamentous, and flaky, without showing granulation due to trabecular tips; the positions of the thickenings seem to show that the three rings are complete and distinct.

C. The forms in which the ground plan of the calicles is more or less obscured by the elements being too flaky.

- P. Cape Verde Islands* 2 (Pl. I. fig. 3). The horizontal flakiness of the septa does not disguise the fundamental pattern of the trabeculae. See also A.
- P. Barbadoes* 4 (Pl. II. fig. 1). The flakes especially pronounced in the walls.
- P. Guadalupe* 6 (Pl. II. fig. 3). Walls are tossed into a flaky reticulum, but this coral appears to belong to D.; the flaky calicles are possibly the result of pathological wall proliferation.

- P. Barbuda* 2 (Pl. II. fig. 9). The tendency to flakiness is not sufficient to obliterate the trabecular pattern.
- P. Florida* 1. The flakiness is extreme, but the rings of round holes show the inter-septal loculi, and other spaces, e.g. those between pali and central tubercle, indicate the normal *Porites* pattern disguised.
- P. West Indies* x. 17 (Pl. V. fig. 6). The wall elements are melted down into smooth irregular masses, like flakes.

D. The "astræoid" group. The names "*astræoides*" and "astræoid" occur very frequently in this Volume, and it is necessary to be explicit as to the sense in which I intend them to be understood, wherever they are used in these pages. The first term has been inherited, as the name of an imaginary species (see the Historical Sketch, p. 3). Our attempts to explore this species have resulted in the recognition of the following facts: (1) that so far as growth-form is concerned, we can no longer speak of an *astræoides* group, meaning thereby some special type of growth, for the term seems to cover any form not branching; but (2) inasmuch as the species "*astræoides*" was intended for massive and explanate forms characterised by a certain type of calicle, it is legitimate to apply the name "astræoid" to that type of calicle, since it has a distinct character of its own. The astræoid calicle then is one in which the pali remain undeveloped in the base of a large deep open fossa, its visible wall is formed by the wall ring, with an occasional appearance as well of the ring joining the septal granules, at least in cases where the walls thicken. But the typical calicle of this group shows only the wall-ring, the inner synapticular wall remaining deep down.

- P. Guadalupe* 6 (Pl. II. fig. 2). The septa are smooth, sharp, frequently irregularly thickened by traces of septal trabeculae. Fig. 3 shows a portion of the same, when the walls are proliferated into a flaky reticulum, cf. C.
- P. Antigua* 4 (Pl. II. fig. 7). The septa are blunt and sometimes knobbed.
- * *P. Barbuda* 3 (Pl. III. fig. 1). The calicles vary in depth; where shallow the skeleton appears somewhat solid though perforated by nearly symmetrical rings of round pores, showing the typical structures.
- * *P. Anguilla* 2 (Pl. III. fig. 3). The calicles vary in depth; the skeletal elements are rough, and with great irregularity of internal arrangement.
- P. St. Thomas* 5 (Pl. III. figs. 6 and 7a). The septa are long, somewhat straggling, and thin, but not specially sharp-pointed; occasional pali and central tubercles visible. In fig. 7a, the septa and skeletal elements generally are slightly thicker. Fig. 7b is of the astræoid *Porites* called "*incerta*" by Duchassaing and Michelotti; while the skeleton of the walls is thicker, the septa are shorter and taper to sharper points.
- P. Belize* 2 (Pl. I. fig. 6). The septa are very short and very sharp, but the elements are all continuous, that is show no breaking up, cf. *P. West Indies* x. 28.
- * *P. Belize* 3 (Pl. I. fig. 7). The septa join with reticulum; columellar tangle high up in the fossa.
- P. Florida* 6 (Pl. IV. fig. 1). The septa not sharp but knobbed; columellar tangle or plate not far down.

* These forms, with the "columella laxa," would apparently have been called *Cosmoporites* by Duchassaing and Michelotti; see above, p. 7.

- P. Bahamas 1* (Pl. IV. figs. 2, 5, 6). The septa are short, irregular, and slightly knobbed. See also A.
- P. West Indies x. 27* (Pl. VI. figs. 6 and 7). The septa are irregular in length and thickness, with sharp or bent tips.
- P. West Indies x. 28* (Pl. VI. fig. 8). The septa are thick, wedge-shaped, with very sharp points; the thick skeletal elements are so perforated as to appear broken up at the surface.

APPENDIX TO TABLE IV.

One additional variation which has been mentioned once or twice in the descriptions deserves notice. It is of special interest taken in conjunction with the fact that the calicles of the Atlantic and West Indian *Porites* differ from the Indo-Pacific forms in the greater thickness of their skeletal elements. Calicles appear with quite a delicate filigree skeleton at the surface, but on close examination this surface pattern appears as if it were standing on a flaky layer. The section shows, however, that these are not flakes but sudden thickenings of the deeper elements. It is impossible to say for certain what is the meaning of this. It might perhaps, on the one hand, indicate that the thickness of the elements characteristic of the *Porites* of this region is secondary, and that the thinner skeleton of the Indo-Pacific *Porites* was the original condition, and that we could see in these cases a transitional process from the one condition to the other. But on the other hand of course the delicacy of the surface elements in these individual cases might be secondary.

The forms in which this sudden thickening just below the surface has been most noticed are:—

- P. Florida 2.*
P. Florida 5.
P. Bermuda 1.
P. West Indies x. 14.
P. West Indies x. 23.

NOTE ON THE BLUE COLOUR OF INDIVIDUAL CORALLA.

On p. 50 attention is called to the blue colour which appears sporadically in the Stony Corals. It seems to differ from the ordinary colouring matters which are withdrawn with the living layer, leaving the skeleton white. The blue colour very frequently persists, and further, is not removed by any ordinary bleaching process. In this persistence and resistance to bleaching it resembles the normal blue colouring matter of *Heliopora caerulea*,* but whether

* See Moseley, Phil. Trans. clxvi. part 1 (1876) p. 102.

it is the same, and why it should suddenly find its way into specimens of Stony Corals, also whether it only attacks stray specimens, or is normal to certain varieties, are points to be investigated. In Vol. I. p. 47 of this Catalogue (*Madrepora*) Brook seems to have regarded it as purely accidental, for one of the "species" accepted by him, with the suspicious name "*multiformis*" (Ort.), included a few blue specimens, and further the specimens labelled by Brook *Mad. secale* are also blue and white mixed. In neither case did he mention the fact in his descriptions.

SUPPLEMENTARY LIST OF GONIOPORÆ,

CONTINUED FROM VOLUME IV.

SUPPLEMENTARY GONIOPORÆ.

PREFATORY NOTE.

SINCE Vol. IV. was published, interesting new specimens of this genus have been added to the collection, while a few others, which had for various reasons been overlooked, have come to light. An account of these will be in place in this Volume, which closes the Poritidæ.

Some explanation may naturally be required of the fact that specimens could be overlooked. With regard to many genera such a confession might argue very careless sorting, but not with regard to this. The liability to confuse *Porites* with *Goniopora* was noted again and again in Vol. IV. Indeed, the earlier writers had no settled criterion, and confused them freely. The distinguishing characters which have been adopted in these three volumes of the Catalogue had to be worked out in the course of their preparation.

But it is not only with *Porites* that *Goniopora* may be only too easily confused, but also with certain forms of Astræids. As related in the historical review of the genus given in Vol. IV., *Goniopora* was at one time classed with the Astræids. It is not, then, surprising that specimens, such as those figured, say Pl. VIII., figs. 4 and 7a, may, in the preliminary sortings, very easily find their way into other groups, from which they are only rescued when those groups themselves are submitted to close examination.

The designations given in this Supplement continue, where possible, the different series begun in Vol. IV. This affords an illustration of the simple method of adding up, fact by fact, our knowledge of the genus.

The presence of fossil *Goniopora* in Jamaica, now recorded in this Catalogue, is of more than ordinary interest, because of the additional light they throw on the history of the genus. No recent forms are known from any part of the West Indian or Atlantic area. Yet it was at one time plentiful along the eastern shores of the Atlantic, as we may gather from its presence in the Bracklesham beds of Hampshire (Eocene), its abundance in the Paris Eocene and Mediterranean basins (Eocene and Miocene). The bearing of these facts upon the suggested connection (in the Miocene) between the Mediterranean and the West Indian regions must be left to geologists. The oldest European records of the genus occur in Austro-Hungary (Upper Cretaceous), and in the Crimea (Lower Cretaceous). (See Table II. p. 168, Vol. IV.)

SUPPLEMENT TO GROUP I. (Polynesian *Goniopora*). Vol. IV. p. 36.

(CONTINUATION OF FIJIAN FORMS.)

153. ? *Goniopora* Fiji Islands (3)2. (*G. Fidjensis secunda*.)

["Feejee Islands," coll. Wilkes Expedition, 1838-1842.]

Syn. *Porites limosa* Dana, Zooph. (1848) p. 563, pl. lv. figs 2, 2a.

Description.—The corallum is massive, normal growth unknown. The original specimen, was a flat-topped cake, some 7.5 cm. high, and 20 cm. in diameter. It had had sediment deposited on it and had died down in the centre. This dead patch was surrounded by a compact ring of stout lobes, with flat, vertical outer faces, closely applied laterally to one another and to the original mass.

The calicles are large, 1.6 mm., irregularly polygonal, shallow, and "plain at bottom." The walls are steep, thin, and roughly granular or echinulate.

The septa are obtuse, but thin, and appear to be very irregular in their number and fusions; about thirteen are shown in the original figure. The pali, six in number, are prominent.

It appears to grow in shallow waters, near the shores, where it is often muddy.

On p. 53 of Vol. V. it will be found that I was forced to regard this as a *Goniopora* and not a *Porites*.

In favour of the latter diagnosis we have the original evidence of Dana endorsed by Dr. Verrill. But on the other hand, the artist's figure, 2a, pl. lv., shows more than twelve septa with short forkings half-way between the pali and the wall. Dana's own reference to the septa is very inadequate, "obtuse and thin." We remember also that Dr. Verrill considered that in *Porites* the septa varied from "twelve to twenty-four."*

The point as to the real position of this coral can only be decided by reference to the original specimen.

ELLICE ISLAND FORMS.

(No *Goniopora* were described in Vol. IV. from this locality.)154. *Goniopora* Ellice Islands (4)1. (*G. Elliciana prima*.) (Pl. VII. fig. 9.)

[Funafuti, coll. W. J. Sollas; British Museum.]

Description.—The corallum is thin, encrusting, with sharp, thin edges.

The calicles are shallow, subcircular or polygonal, under 2 mm. in diameter. The walls

* Trans. Com. Acad. i. part 2 (1871) p. 503.

are low, thick, round-topped, but not conspicuously reticular, composed rather of the thick, solid, peripheral ends of the septa. The septa appear to be uniform all round the calicle, and to slope slightly from the walls, where they are wedge-shaped with conspicuous granules along their edges, and so lose themselves in the open, flat base of the fossa which is occupied by a mass of granules without apparent arrangement; close inspection, however, shows them to be especially large at the points of fusion of the septa, which can then be seen to be arranged in the typical manner.

Shallow calicles with a tendency to have the edges of the septa broken up into granules are characters belonging to *very thin* explanate forms, as already described in Vol. IV. Three other examples are already known of this, viz. *G. Maldives 1* (see Vol. IV. Pl. VII. fig. 1), and *G. North-West Australia 2* (Pl. IV. fig. 1), and *G. China Sea 2* (Pl. V. fig. 4).

The specimen is not only interesting because it supplies us with another typical instance of this method of growth, with its characteristic calicles, but because it is encrusting a dead fragment of an entirely different kind of *Goniopora*, see below, *G. Ellice Islands 3*, spec. *b*. This latter point claims attention in a genus which does not seem to be at all common. It shows that in one and the same locality we may have forms quite distinct from one another living side by side.

a.

Zool. Dept. 1903. 4. 3. 2.

155. *Goniopora Ellice Islands 2*. (*G. Elliciana secunda*.) (Pl. VIII. fig. 1.)

[Funafuti, coll. W. J. Sollas; British Museum.]

Description.—The corallum apparently started as a low, convex mass, encrusting the worn and loose fragment of a branching coral. This latter apparently rolled over, and the *Goniopora*, with great distortion of the calicles, has had to grow up round it, with the result that it appears as if it had been forcibly wrapped round the fragment to which it is attached.

The calicles are shallow and open, like those of encrusting forms, ranging from 2 to 3.5 mm. across. The walls are low, thick and well marked, composed of a coarse, irregular, rather flaky reticulum, the flakes running out into free ends. The septa, which show clear traces of the typical formula, are thin, jagged and very short, because they soon join the large columellar tangle which is of the same flaky reticulum as the walls.

At the point of most rapid growth, the calicles are a little deeper, the wall reticulum a little more open and filamentous, the septa, of which some eight are conspicuous as thin plates, are reduced, by the large size and irregularity of the perforations, to filamentous lacework. The columellar tangle is smaller and more openly reticular.

Here and there the wall reticulum and the columellar tangle run together and obscure some of the septa.

This coral is clearly an abnormal specimen, and it is impossible to say what its calicles would have been like had it found a stable body to rest upon.

The tendency of the skeleton everywhere to become reticular is obviously pathological, for it goes to the greatest extreme in that part which suffered most by the rolling over of its

support. We can trace stages in the proliferation of the reticulum, recalling those shown in the Paris basin group which would thus appear to have grown in an unfavourable environment. All traces of calicles may be obliterated in a flaky reticulum, as seen in Vol. IV. Pl. X. fig. 6, with intermediate stages not unlike fig. 5 of the same plate, which seem to lead us gradually to the calicles now figured.

This coral, which the formal systematist might be inclined to throw aside as abnormal, is of great interest. For we can learn from such accidents almost as much as we could from any experiments in skeletal variation that we could devise. It is only by a study of variation, however caused, that we shall ever arrive at a natural system of the corals. For an instructive case see *Porites Bahamas 1*.

There are two large double calicles of a shape and character which suggest that they are due to abortive fission.

a.

Zool. Dept. 1903. 4. 3. 1.

156. *Goniopora Ellice Islands* (4)3. (*G. Elliciana tertia*.) (Pl. VIII. fig. 2;
Pl. XVII. fig. 16.)

[Funafuti, coll. Sollas; British Museum.]

Description.—The corallum, having been apparently attached to the side of some steep portion of the substratum, grew out laterally and upwards, hoof-shaped, faintly and irregularly cloven, and with the sole uppermost. The living colony covers the sharp edge of the hoof extending backwards like a thick cushion over the previous cushion-shaped soles, and downwards as a thin creeping layer with conspicuous, wrinkled, epithecal pellicle. The condition of the fracture suggests that the whole stock has been built of at least two such hoof-shaped colonies. The specimen came away completely from the rock, exposing the epithecal base of the original colony.

The calicles are subcircular, with immense numbers of intracalicular buds; they are as large as 4 mm. round the growing edge of the hoof, but on each side, upper and lower, of this edge they decrease in size to 2 mm., but decreasing more rapidly on the upturned sole than on the lower side. They are deepest (3 to 4 mm.) near the extreme edge, but get shallower till on the under surface, on nearing the epithecal film, they are flush with the surface. The walls are thick and regularly reticular over the upper surface and show the septal elements as thin radial lamellæ, which seldom run right across the wall, but either end up against a zigzag median line or fork and are lost in the reticulum. Along the growing edge of the hoof, there is a tendency for the whole skeleton to turn into a lamellate stroma such as that described as typical of the expanding sheaf method of growth and figured Vol. IV. Pl. VII. fig. 4. This lamellate character is seen in all the calicles of the upper surface, but less pronounced and more regular than right at the edge, forming a reticulum recalling that seen in patches on *G. North-West Australia 6*, see Vol. IV. Pl. IV. fig. 6. Just below the sharp edge of the sole, the walls suddenly thin away so that many are simple latticeworks, but gradually thicken again in the typical manner, remaining simple and not reticular as they near the epitheca.

The septa are thin and lamellate, and in the shallow calicles show the typical formula. In the deep calicles, they are close rows of long delicate spines, which unite deep down to form a light columellar tangle without symmetry. As the calicles become shallower, the septal teeth become shorter and more typical, and the columellar tangle more compact, till in the shallowest it is a flat, nearly solid floor covered with coarse granules which shows clear traces of the typical rosette arrangement of jagged and straggling granules.

In the longitudinal section, the walls are stout and solid looking, the septa are irregularly perforated with very large and very minute pores irregularly scattered.

This specimen, with its method of growth, which may have been purely accidental, is interesting because it shows some of the same variations of the calicles as are seen in *G. North-West Australia* 6, and perhaps throws some light on them. It certainly suggests that the deep calicles with regularly reticular walls, which are only so far known in these two representatives of the genus,* may be more favourably situated than those with thin lattice walls.

In this one specimen, then, we have a very wide range of calicle variation, and obviously all of them due to the accidents of position; see observation under the last heading.

In general colour and appearance, it recalls *G. Great Barrier Reef* 2 from Palm Islands. But its skeletal elements are more delicate, and the septa do not form such conspicuous wall striæ, and there is no median furrow on the walls.

On the dead parts of the upper surface, what seems to be a young colony of four calicles appears in a deep epithecal saucer. This, however, is hardly a fresh colony in the sense that it started *de novo* from a larva. It is rather a minute portion of the old colony, which has survived and protected itself with an epithecal wall from the surrounding decay. This may be gathered from the fact that the fossæ run down into the old colony.

a.

Zool. Dept. 1903. 4. 3. 3.

There is, further, a worn massive fragment which may be the same kind as this. Its skeletal elements are thickened by post-mortem aqueous corrosion. The specimen *G. Ellice Islands* 1 encrusts a part of it.

The calicles are from 3 to 4 mm. across, were evidently somewhat deep, the walls were reticular, and the septal formula complete. It is clear that with the range of calicle variation shown on specimen a, this dead fragment may, so far as size of calicles is concerned, safely be placed here.

b.

Zool. Dept. 1903. 4. 3. 2.

157. *Goniopora Ellice Islands* (4)4. (*G. Elliciana quarta*.) (Pl. VIII. fig. 3;
Pl. XVII. fig. 17.)

[Funafuti, coll. Sollas; British Museum.]

Description.—The corallum forms tufts of short, thin, bent stems, which fuse together, swell into rounded and angular knobs at their tips, and frequently divide. The stems are from 7 to 10 mm. thick.

* We find a similar variation in *Porites Fiji Islands* 18, see Vol. V. p. 56.

The calicles are indistinguishable in size and character from those of *G. Great Barrier Reef 12*, except perhaps the granules may be a little coarser.

This specimen might be a fragment of *G. Great Barrier Reef 12*. It is unfortunately only a small fragment and does not show any part of the base of the stock. It is impossible, therefore, to say what its real method of growth was; that is, whether it is an independent tuft formation, or a tuft as a secondary modification of the edges of an explanate form. For characters see the description and figures of *G. Great Barrier Reef 12*, Vol. IV. p. 58.

This is one of the few cases I have met with of two corals from different localities resembling one another so closely as to appear as if they were parts of one and the same stock. It is useless to ask "Are they of the same species?" until we know what is meant by species. One case of calicle resemblance, for here we do not know the growth-form, is rather a small point upon which to build up wild speculations. Our duty is to study the local forms and then endeavour to discover their inter-relationships. I should not be surprised if some new conception of classification based upon the locality but embracing also larger geographical areas will not have to take the place of that which finds its expression in a genealogical tree.

a.

Zool. Dept. 1903. 4. 3. 4.

158. *Goniopora* Bay of Panama (1)1. (*G. Panamensis prima*.)

[Pearl Islands, 4-6 fathoms, coll. F. H. Bradley; Yale College Museum.]

Syn. *Porites excavata* Verrill, Trans. Com. Acad. i. part 2 (1867-71) p. 504.

Description.—The corallum thickens so as to be glomerate, and irregularly hemispherical.

The calicles vary from 1.2 to 1.5 mm. "polygonal and rounded, well-defined, deep, and excavate." Walls firm, regular, moderately thick, elevated, and thickly covered with coarse rough granules. The septa are very distinct, narrow at the summit, wide below, extending to the columella, varying in number from ten to twenty-four, commonly fifteen to eighteen; their edges are lacerate and sides roughly granulous. There are five to twelve pali, small but prominent, roughly spinulose or granulous. Columella little developed, trabecular, frequently absent.

The colour of the unbleached corallum is a dull brownish-yellow.

Two specimens of this coral, about 20 cm. in diameter and 10 cm. high, were brought up by divers. They were mistaken by Dr. Verrill for *Porites*, but the description, which gives the average number of septa as from fifteen to eighteen, shows that it was a *Goniopora*. The numbers "ten to twenty-four" would not alone be conclusive, for such numbers might be given by normal and abnormal or double calicles, great numbers of which are sometimes developed as in Mr. Quelch's *P. mirabilis*.* Though this is the conclusion we are driven to by Dr. Verrill's description, the variations "ten to twenty-four" are certainly somewhat remarkable (cf. *G. Jamaica 1*, p. 159), and would appear to include the very young calicles appearing in the interstices.

* Cf. Chall. Rep. xvi. (1886) p. 185, pl. xi. figs. 5, 5a, and this Catalogue, Vol. V. part 1, p. 164.

SUPPLEMENT TO GROUP II. (Vol. IV. p. 48.)

AUSTRALIAN FORMS.

159. *Goniopora* Great Barrier Reef ⁽¹⁵⁾13. (*G. Queenslandiae tertiadecima*.)
(Pl. VIII. fig. 4.)

[Moreton Bay, coll. W. Saville-Kent; British Museum.]

Description.—The corallum is a detached, massive, bean-shaped nodule, which rested, in part at least, upon low prominences of its surface, the tips of which seem to have suffered from contact with the substratum. Between these prominences the surface is smooth.

The calicles are nearly flush with the surface, being only shallow depressions, subcircular, and varying from 1 to 2 mm. in diameter. The walls are only the slight ridges between the depressions and not raised as steep ramparts. They are everywhere obviously composed of the thick, peripheral ends of the septa, but occasionally show a tendency to be reticular. The septa, about twenty, with granular and frosted edges, taper towards the centre, and are usually symmetrically arranged on each side of the directive plane. The missing parts of the typical formula are apparently always those near the directives. The columellar tangle is seldom visible at the surface, being replaced by irregular groups of minute septal teeth or granules, which get smaller and smaller as the septa taper inwards. Occasionally a few of the granules near the centre show traces of beginning to rise as pali.

This *Goniopora* occurs further south than any of the other known representatives of the genus. It seems to have been lying on coarse sand, some of which was found embedded in the small knobs on which the specimen rested.

The habit of the specimen instantly recalls that of certain *Porites* and *Montipores* which also lie free on a sandy bottom near the Amirantes Islands in the Indian Ocean. In all of them the calicles are more or less flush with the surface, with the same close skeleton, the same kind of frosted granulations, and the same yellowish-sandy colour. Further, detached fragments of other *Porites* sometimes acquire the same kind of skeleton and colour, compare Vol. V. p. 80 (No. 1904. 10. 17. 37). It is difficult then to avoid the conclusion that the so-called specific characters of this coral are due to its environment. We do not yet know whether it is an accidental growth, derived perhaps by fracture from some fixed stock, or whether some representative of the genus has acquired the habit of living in this way, its parental polyp having perhaps settled upon some small loose pebble or shell which is gradually coated over.

The specimen is further interesting because patches of it are being killed by an alga which hollows out the skeleton. In the case of *G. Great Barrier Reef* 6, p. 53, Vol. IV., the alga was mainly confined to the walls, which in that coral are high, but here it is in both septa and walls; the former being almost as near the surface as the latter.

160. *Goniopora* Great Barrier Reef ⁽¹⁵⁾14. (*G. Queenslandiæ quartadecima.*)
(Pl. VIII. fig. 5.)

[“Great Barrier Reef,” coll. W. Saville-Kent; British Museum.]

Description.—The corallum is smooth and massive, oval in outline, with both upper and lower surface somewhat flattened.

The specimen had rolled over and was free.

The calicles are shallow, concave depressions, varying slightly in depth and concavity, and in size from 2 to 3 mm. The walls are the simple ridges between these concavities, for the most part sharp, very granular, with traces here and there of a smooth zigzag thread, sometimes, however, somewhat blunt, flat-topped and striated by faint septal ridges. The full number of septa is developed, each being a long row of coarse, irregular granules, broad, and sometimes appearing doubled near the wall, but tapering away to minute single granules near the centre. The formula is obscure owing to the regularity of these radial structures, but can be made out by close observation. The typical rosette of pali can also be made out with a central tubercle in line with the directive septa.

The colour of the unbleached coral is a dark sepia.

The individual specimen seems to have been hollowed out from the base of attachment upwards till a breach was made in the upper surface. This breach was covered over by fresh coral. The stock then seems to have rolled quite over and become free. The living layer has grown up covering the old base of attachment and dipping down into the hollow in the old stock.

An extreme example of a *Goniopora* with long, straight septa, the edges of which are so granulated as to appear double at their thicker peripheral ends, is figured in Vol. IV. Pl. X fig. 1, which is from a specimen of the classical *Astræa bellula* of Michelin, re-discovered in the British Museum (see Vol. IV. p. 133). The character is rare.

a.

Zool. Dept. 1905. 9. 21. 1.

161. *Goniopora* Great Barrier Reef ⁽¹⁵⁾15. (*G. Queenslandiæ quintadecima.*)
(Pl. VIII. fig. 6.)

[Thursday Island, coll. Pace; British Museum.]

Description.—The corallum is small, round or oval, cushion-shaped, of varying convexity and creeping irregularly over a substratum of shells and other organic remains, or over earlier colonies.

The calicles are polygonal, from 2 mm. in diameter to nearly 4 mm. (in the more convex colonies), and from 1.5 mm. deep in the less convex colonies, to 4 mm. in the more convex colonies. The wall is steep, thin and lattice-like, but appears to be thickened by regular, vertical, septal striæ. The top edges are without distinct zigzag or median line, and are

irregularly jagged or denticulate, tending to be reticular. The septal striæ have toothed edges; in the deeper calicles, the teeth may lengthen into smooth, bent spines, pointed or forking. These, seen from above, obscure the columellar tangle. But, in the shallower calicles on less convex stocks, the septal teeth are more granular and frosted, and join a large columellar tangle with the usual palic formula, the septa themselves also showing, in such calicles, the typical formula.

There are three specimens showing striking variations, which, however, appear all to be due to accident.

The smallest, *a*, is the least convex, the calicles are about 3 mm. across and about 2 mm. deep, and the septal teeth or plates and the pali are frosted granular knobs, the septal formula being complete. We have, in fact, the primitive * calicle with the walls somewhat raised into thin latticeworks, roughened by the vertical septal striæ. Specimen *b* shows on one side a dead colony with the characters of *a*, but on the other a fresh colony which is apparently budding so rapidly that all the calicles are much smaller. The walls are thinner and slightly taller. The colony *c* is very convex, and the calicles on the top are very deep and as much as 4 mm. across. Instead of the columellar tangle, the base of the fossa is occupied by spinous, slightly-forking septal teeth, which project progressively further into the fossa. In these deep calicles there is a tendency for the primary septa to be rather more conspicuous than the secondaries.

Assuming that we are right in putting these together, they show how sensitive the calicles are to slight variations in growth-form, and even speed of growth. They are all three comparatively simple, and fortunately show serial variations on the primitive colony and calicle. The calicle tends to produce higher and thinner walls as the convexity of the colony increases. Compare diagram E, fig. 2, p. 24, Vol. IV.

a, b, c.

Zool. Dept. 1903. 4. 3. 5-6-7.

162. *Goniopora* Torres Strait 1. (*G. Australiæ aquilonaris prima*.) (Pl. VIII. fig. 7a.)

[West Island, coll. H.M.S. "Alert"; British Museum.]

Description.—The corallum is very thin, and encrusting, with thin, sharp edges hanging free; from 3 to 5 mm. thick in the central part.

The calicles, hardly visible in the coral when freed from organic matter and bleached, are 2 mm. in diameter, as slight concave depressions sometimes hardly traceable to the naked eye. The walls are the low, rather broad, but often hardly discernible ridges between the depressions. Their tops appear rather smooth, and to consist of an irregular arrangement of large, squarish or angular flat-topped granules, as continuations of the squarish granules which run along the upper edges of the septa. These latter diminish gradually in size towards the centre. The septa themselves run regularly side by side, showing faintly the typical formula, but, at least in the calicles near the edges of the stock, the calicle centre is excentric, and the longer septa show a tendency on each side of the directive plane, to curve round upon the shorter

* See Vol. IV. p. 19.

directive, usually called the ventral septum. Where the septa meet, the granules may fuse to form pali or remain separate, but they do not rise at all to break the curve of the concavity.

A list of the known thin, explanate *Goniopora* will be found on p. 174 of Vol. IV. A comparison of their calicles, as given in the magnified figures, is very instructive. The thinnest forms tend to have very granular surfaces, representing the tips of the short trabeculae, cf. Pl. IV. fig. 1, and Pl. V. fig. 4 of Vol. IV. with the figure of this coral. An interesting variation on these is shown on Pl. V. fig. 5 of Vol. IV., in this the trabecular elements are feebly developed as compared with the horizontal; the surface is consequently composed of flakes. These specimens are also instructive from the fact that it is impossible to group them under a single heading, because though showing the same general characters, they all differ in many ways, and are further distributed so widely. In the meantime, therefore, in view of the extreme plasticity of coral-stocks, we can do nothing but regard their special characteristics as due to their localities. Their genetic relationships can be only puzzled out in time. The fact that the calicles seem to vary with the form of the corallum no matter how accidentally that form is acquired, should put a stop to all attempts to base specific affinities upon calicle resemblances alone. For another striking instance of this total nonplussing of the prevailing attempt to guess at specific relationships, see the next coral, *G. North-West Australia* 7.

a, b. In spirit, with a bleached fragment.

Zool. Dept. 82. 2. 23. 120-1.

163. *Goniopora* North-West Australia (77)* (*G. Australia occidentalis septima*.)
(Pl. VIII. fig. 8.)

[Adolphus Island, coll. Saville-Kent; British Museum.]

Description.—The corallum is massive, but owing to the destructive action of a sponge close under the surface, it is apparently thin (4 mm.) and encrusting, with edges supported by very wrinkled epitheca, which follows the irregularities of the substratum.

The calicles are subcircular, 2 mm. in diameter, shallow. The walls are low, round-topped, not of even thickness all round, finely reticular, and frosted. The septa do not appear as wall striæ, but begin to project slightly below the margin, their thin edges, very frosted, descend vertically for a short distance and then curve out concavely to join the large columellar tangle. The full septal formula is very apparent. In sections the septa are very perforated, the round pores frequently arranged in series which slope steeply upwards from the wall towards the centre. The columellar tangle is very large and flat, and appears to consist of numbers of frosted granules; the palic formula is confused, owing to the fact that frosted granules are not limited to the principal points of septal fusion. Near the thin edges of the corallum, the usual rosette is visible to the naked eye.

What remains of the natural colour of the coral extends some 3·5 mm. below the surface, and some 2 to 2·5 mm. below the level of the surface of the columellar tangle.

The growth form of this coral is very puzzling. It appears, as stated, to be thin

* For the earlier forms, see Vol. IV. p. 63.

encrusting, and the calicles are those typical of that growth-form; see Vol. IV. Table IVa. p. 176. But on examination of the section, parts of it are seen to be continuous with the remains of a thick *mass* of the same growth. This mass is, however, burrowed through and through, apparently by a boring sponge, and is quite rotten throughout. This destroying organism follows up the growing coral and burrows just below the living polyps, making gangways and slits, the roofs of which appear to be the natural under-surface of a creeping colony. Indeed, patches of the living layer were apparently killed, and the destroying organism reached the surface, but the coral seems to have been able to creep over again. In this way, its method of growth, owing to its perpetual struggle with the sponge, is one of continual encrusting over the parts burrowed through, and its calicles are characteristic of the encrusting method of growth.

Since the two chief characters of this coral are due to the action of the sponge, its specific affinities must necessarily be left until the Adolphus Island reefs are again explored, for until then we shall never know what the calicles are like in a specimen which escapes the ravages of the sponge.

The only other known *Goniopora* from North-West Australia are too widely distributed to be of any assistance in this respect, the nearest occurring over 200 miles away.

a.

Zool. Dept. 92. 12. 1. 211.

SUPPLEMENT TO GROUP IV. (Vol. IV. p. 85.)

INDIAN OCEAN FORMS.

164. *Goniopora* Christmas Island 1. (*G. Natalis prima*.) (Pl. VIII. fig. 7b.)

[Flying-fish Cove, coll. Andrews; British Museum.]

Description.—The corallum is explanate, thickening irregularly into convexities, with lobate edges, pendent or encrusting, here sharp with projecting epitheca, there blunt and rounded. The thicknesses are variable up to 1 cm.

The calicles are small, average 2 mm. in diameter, fairly deep, subcircular, but more sharply polygonal when the skeleton is cleaned of animal matter. The walls are an irregular lattice-work with jagged edges, here thin and ragged and there thicker, with traces of close, narrow septal plates joined by a zigzag thread. The septa form narrow striæ down the faces of the walls, very variable in size, many quite rudimentary, some six or seven running out, bent and irregular, to unite with a straggling, loose, reticular columellar tangle. The radial symmetry is thus greatly obscured, only feebly shown in the septa, not found at all in the columella or the pali, and only faintly visible in the interseptal loculi, which, owing to the irregularity of the septa seldom seem to run deep into the coral.

The section shows a very irregular reticulum, the elements of which are coarse and

irregular, and mostly stream upwards towards the surface, without any pronounced individualising of separate trabeculæ.

The coral seems to have been of a greenish colour; traces of it are still apparent, and the preserving spirit is also so tinted.

The calicles of this coral are interesting in the absence of regularity and clearly defined radial symmetry. This in itself is not so rare, but here the skeletal elements are rather coarse and bold in spite of the smallness of the calicles, and further, many of the septa remain quite rudimentary and do not appear to join the columellar tangle. It is this last fact which is peculiar.

A preliminary notice of this coral was given in a list of Dr. Andrews' corals from Christmas Island, which was published in the Proc. Zool. Soc. London for 1903, p. 123.

a. In spirit, with a few bleached fragments.* Zool. Dept. 99. 5. 12. 34.

165. *Goniopora Madagascar* 1. (*G. Hannonis prima*.)

[Madagascar, coll. Esper; ?]

Syn. *Madrepora conglomerata* Esper, Pflanzenth. Suppl., i. p. 71, pl. lix.

Porites conferta Dana, Zooph. (1848) p. 557.

Description.—The corallum rises from a narrow stalk by forkings at small angles, but at very irregular intervals, into a compact and regularly thickening cluster of long sinuous stems, round or oval in cross sections and showing long fusiform swellings. In spite of the crowding, there seems to have been but slight tendency for the stems and branches to fuse. The terminals over the whole mass all seem to reach to about the same level, and are fairly uniform in length, about 2 cm., and are either sharp and tapering or blunted and as if beginning to fork. The living layer is 3 to 4 cm. deep with the stock itself some 17 cm. high.

The calicles are conspicuous, near the tips they are sharply depressed, crowded, angular. The walls have thin, sharp, echinulate edges. The septa, fifteen to twenty in number, begin below the edges of the walls and slope irregularly, making the cavity funnel-shaped; they are rather lamellate ("blättrichte"), wavy, laterally echinulate and fuse together. The pali at the tips of the septa are not clearly differentiated. The central fossa is small or obscured by a central tubercle. In the older parts, the walls thicken and are then covered with granules like those forming the edges of the septa.

The colour of the very heavy and dense stock was said to be a greyish-brown.

This description is taken from Esper's text and figure. He informs us that he had several exactly similar specimens from the East Indian seas, but ("vorzüglich") in greatest abundance

* On one of these bleached fragments, a chip from the edge about 1.8 cm. long and 8 mm. broad, there is an early stage in the development of a Bryozoan, consisting of the parental zooid with one bud, and showing a relationship between them which deserves attention.

from Madagascar. The text does not make it absolutely certain that the specimen figured itself came from that locality, for it is not quite safe to take the words exactly similar specimens ("ganz übereinstimmende exemplare") too literally. Differences which are now thought to be of importance were then frequently not recognisable by persons unprepared for them. Hence, there is an element of doubt as to the locality, and, consequently, as to my designation.

The specimen has hitherto been accepted as a true *Porites*, but owing to the fact that it had from fifteen to twenty septa it has here been transferred to the genus *Goniopora*.

If this is correct, the stock is of interest in the genus. There is no other known representative of it with so fluent a method of growth. Most are stiff and formal, see Plates XI. to XIV. of Vol. IV. In this connection it is worth noting that the calicles must have been small, for in the account of figure 59a, which was apparently a true *Porites*, its calicles are said to have been larger than those of this coral.

The confusion which has been caused by Esper's coupling of two such different corals as those figured pl. lix. and lixa., as representatives of one and the same species, would fill several pages to relate. Brief references will be found above, pp. 115, 116, as to the way Lamarck was influenced. Dana was the first to rename the branching form and call it *Porites conferta*. Out of the confusion we emerge with the simple facts that there is a *Goniopora* with this remarkable branching growth-form, and that it *may* be found at Madagascar.

ZANZIBAR.

There are three interesting remains of a *Poritid*, which appear to be those of *Goniopora* from Tertiary (Neogene) formations of Zanzibar.

a. The well-preserved remains of a *Poritid* showing a well-developed reticular skeleton consisting of stout straight trabeculae joined by short thick cross-pieces, so that the meshes are all uniformly small and rounded. There are no good transverse sections, and the portions of such sections which are visible show no certain traces of the arrangements of the calicles. Here and there one sees what appear to be rather large rings of interseptal loculi, but for the most part, the meshes of the coral show no symmetry at all. The stoutness of the elements, trabeculae and cross-junctions is a slight argument in favour of their being those of *Goniopora*, and not of *Porites*. The specimen seems to have encrusted a finger-shaped mass of some coral conglomerate, one end of which was swollen. The *Goniopora* had at one time enveloped this swollen end, and the section shows a clear sharp line between the earlier conglomerate and the more recent coral.

b and *c* are irregular, rough, bent, finger-shaped masses of the same coral conglomerate. A cross-section of *c* shows it to have belonged to what appears to have been a similar *Poritid*, but apparently of a branching form, because the skeletal elements appear to have been arranged concentrically.

Nothing *certain* can be made out beyond the fact that these fragments are the remains of a *Poritid*, and probably of a *Goniopora*. They are of great interest, and deserve more thorough investigation.

a, b, c. Presented by J. T. Last, Esq.

Geol. Dept. R. 5354.

SUPPLEMENT TO GROUP V. (Vol. IV. p. 92.)

INDIAN AND PERSIAN FORMS.

166. *Goniopora Persia* (4)4.* (*G. Persica quarta*.)

[Guverchin Kala, N.W. shore of Lake Urmi (Miocene), coll. Loftus; British Museum.]

Description.—The corallum formed rounded slightly compressed nodules.

The surface was pitted by shallow calicles, 1·5 mm. in diameter. The wall had a stout, straight, median ridge. The septa were stout and wavy, forking so irregularly near the walls that the number of points of attachment to the same can only with difficulty be made out. They seem to vary from thirteen to eighteen. There seem to have been short, stout pali, with a stout central tubercle.

This coral was omitted from Vol. IV. because I thought it was a true *Porites*. Re-examination has, however, now convinced me that it is a *Goniopora* or one of those difficult transition forms with septa diminishing in number and showing free forkings round the walls.

There are three nodules, only one of which shows any trace of the surface characters. The other two are unrecognisable except that faint traces of the reticular Poritid skeleton can be seen in the more crystalline part of the fossil. They are placed here provisionally.

a. With thin slices.

Geol. Dept. R. 7089.

b, c.

Geol. Dept. R. 7088.

SUPPLEMENT TO GROUP XIII. (Vol. IV. p. 155.)

WEST INDIAN FORMS.

167. *Goniopora Jamaica* 1. (*G. Jamaicae prima*.)

["Upper Clarendon District" (Cretaceous); Museum of the Geological Society, London.]

Syn. † *Porites reussiana* Duncan, Quart. Journ. Geol. Soc. xxi. (1865) p. 8.

The original description of *P. reussiana* runs as follows: "The corallum is in more or less cylindrical branches, which leave the stem at an acute angle, and are often flattened and always rugged and gibbous. The calicles are large, irregular in size, and shallow, and there are sometimes more than six distinct pali. The septa are from eight to twenty-four (!) in number. Diameter of calicles often $\frac{7}{10}$ inch, that of the branches from $\frac{6}{10}$ to $\frac{1}{2}$ inch."

* For the earlier forms, see Vol. IV. p. 236.

The supposed type of this coral is preserved in the Museum of the Geological Society of London. It was examined by Dr. Vaughan, who rightly suggested that it is a *Litharœa* = *Goniopora*, and added that the figure must be used with a qualification. My own examination of the same specimen leads me to think that there must be some serious error. The specimen is a flattened fragment, not strikingly suggestive of having consisted of cylindrical branches forking at small angles, while the calicles figured are those of some other coral altogether. There is not a character in the drawing which agrees in the remotest with the calicles of the specimen.

The specimen itself is certainly a *Goniopora*. The calicles are faintly depressed with the walls as slight ridges where the depressions touch; the septa slope from the wall edges inwards. The walls are simply the ridges in which the septa of adjacent calicles run confusedly together. The septa are wavy, irregular, and variable in thickness, but radially arranged, and show no such remarkable variation in number as "eight to twenty-four"; they meet in a central tangle of different sizes without any marked formation of pali.

It is a great pity that this, which with *G. Jamaica* 2 are the only *Goniopora* said to come from the West Indies, comes under the suspicion of error, for we do not know for certain whether it comes from the West Indies at all, as it is not the specimen described and figured. A different kind of uncertainty shrouded the specimen described on p. 155, Vol. IV. It was difficult to give any decided opinion as to whether that specimen was a *Goniopora* or not, but in this case there is no doubt about the specimen being a *Goniopora*, but it is the locality which may be open to doubt. We can, however, do no more than record it as it is labelled.

The scarcity of *Goniopora* in the West Indies is somewhat striking, since *Porites* are so common and characteristic an element in the coral fauna. No recent forms are known at all. The presence of these two fossils in Jamaica may perhaps be correlated with the presence of a rich *Gonioporan* fauna in the Western European region, e.g. in the Paris basin and the Bracklesham Beds of England, on the other side of the Atlantic area.

168. *Goniopora Jamaica* 2. (*G. Jamaica* secunda.)

[Jamaica (Tertiary), coll. Lucas Barrett; British Museum.]

Description.—The corallum is a worn fragment of a massive stock. The original surface has been taken off for only a short depth, as we may gather from the condition of the remains of certain Balanids which infested it.

The calicles appear to have been about 1.75 mm. in diameter with reticular walls, the threads of which were mostly continuous with the septa. Walls, septa and columellar tangle seem to have formed together a close network, so uniformly irregular that it is difficult even to trace the calicles at all in the section. Faint indications of a radial symmetry come here and there to light, but it is always difficult to discover where the septa end and the walls begin. The limits of the columellar tangle are also hard to define. As far as I could make out, there appear to have been about fifteen septa.

The vertical section is very perfectly preserved, and shows regular trabeculae with a tendency to be lamellate, and joined together by lamellate or flaky horizontal elements. Tabulae are numerous.

This is a second *Goniopora*, and this time without doubt, from Jamaica, and these two are so far the only members of the genus known from the West Indies. It does not appear to have had any close affinity with *G. Jamaicae* 1. The calicles of the latter are pronounced radial structures, whereas here they are melted down into a close uniform network of flakes and filaments.

a.

Geol. Dept. 46811.

SUPPLEMENT TO GROUP XIV. (Vol. IV. p. 156.)

FORMS WITHOUT RECORDED LOCALITIES.

169. *Goniopora* x. h. (*G. incertæ sedis* h.) (Pl. VIII. fig. 9 ; Pl. XVII. fig. 19.)

[Coll. Poland ; British Museum.]

Description.—The corallum rises from a single stout stem, into an erect, nearly ovate cluster of very thick branches, showing a tendency to divide dichotomously, every division bending up into the vertical, and flattening concentrically round the axis. The first cleavage passes through the axis and divides the corallum right through one of its diameters to near the base, and is nowhere more than 1 cm. wide. The next division runs at right angles to this, a little above it; above this the divisions become irregular, partly because of distortion from worms and Balanids. The living layer is 24 cm. on one side, and 12 on the other, and there are signs as if the stock had begun to lean over.

The calicles vary in size from 2 to 4 mm.; they are subcircular, and nearly uniformly deep. The walls are stout, and stand up sharply and uniformly thick and steep, about 1 mm. over the whole corallum. In the upper parts, where the septa are irregular, the walls are of a ragged lamellate reticulum, but in the lower parts, where the septa are more regular, the latter tend to striate their narrow tops; young calicles bud on the angles of the walls all over the corallum. The septa begin as a number of ragged-edged ridges down the walls which eventually join the columella to the wall as so many straight threads of different thicknesses, not all radially arranged, nor in any well defined radial order, so that the interseptal loculi are very irregular, some large, some small, some obscured by cross threads, some angular, some round. Lower down on the coral, the radial symmetry becomes gradually more perfect, and the interseptal loculi, though of different sizes, are clearly definable pits into the interior of the coral.

The columella is an immense tangle of lamellæ and filaments, open and delicate in the upper calicles, but elsewhere denser and sending up irregular granules and points which form the typical rosette to the naked eye.

The texture of the section is coarse and open, and the skeletal elements themselves are variable, very stout and very thin flakes and threads being intermingled.

This specimen is of considerable interest, not only on account of its growth-form, which recalls the ideal dichotomy of a West Indian *Porites*, e.g. *P. West Indies* x. 14, but also because of the signs of struggle which can be seen between the Balanids settled upon it and the growing coral, the latter always having threatened to overgrow the former.

Stout branching forms of *Goniopora* are known, for instance, from the Seychelles, Singapore and Samoa, but a definite order of growth forking is not usually apparent.

The calicles in their younger stages somewhat recall those figured in Vol. IV, Pl. IX. figs. 1 and 2, which also referred to a specimen from some unknown locality.

a.

Zool. Dept. 1903. 7. 31. 2.

LIST OF THE NEW FORMS HERE DESCRIBED.

(CONTINUATION OF TABLE I. OF VOL. IV., PAGE 162.)

NO.	DESIGNATION AND LOCALITY	DEPTH	HORIZON	REFERENCE TO PUBLISHED FIGURES	MUSEUM IN WHICH THE ORIGINAL SPECIMEN IS PRESERVED	PAGE IN THIS VOLUME.
Supplement to Group I. Polynesian Goniopora.						
153	<i>Fiji Islands 2</i>			Dana's Zoophytes, pl. lv. figs. 2, 2a.	?	147
154	<i>Ellice Islands 1</i> , Funafuti			Pl. VII. fig. 9	Brit. Mus.	147
155	<i>Ellice Islands 2</i> , Funafuti			Pl. VIII. fig. 1	Brit. Mus.	148
156	<i>Ellice Islands 3</i> , Funafuti			Pl. VIII. fig. 2	Brit. Mus.	149
157	<i>Ellice Islands 4</i> , Funafuti			Pl. VIII. fig. 3; Pl. XVII. fig. 17.	Brit. Mus.	150
158	<i>Bay of Panama 1</i> , Pearl Island	4-6 fathoms			Yale Coll. Mus.	151
Supplement to Group II. Australian Goniopora.						
159	<i>Great Barrier Reef 13</i> , Moreton Bay			Pl. VIII. fig. 4	Brit. Mus.	152
160	<i>Great Barrier Reef 14</i>			Pl. VIII. fig. 5	Brit. Mus.	153

NO.	DESIGNATION AND LOCALITY	DEPTH	HORIZON	REFERENCE TO PUBLISHED FIGURES	MUSEUM IN WHICH THE ORIGINAL SPECIMEN IS PRESERVED	PAGE IN THIS VOLUME
161	<i>Great Barrier Reef 15</i> , Thursday Island.	.	.	Pl. VIII. fig. 6	Brit. Mus.	153
162	<i>Torres Strait 1</i> , West Island . .	.	.	Pl. VIII. fig. 7a	Brit. Mus.	154
163	<i>North-West Australia 7</i> , Adolphus Island.	.	.	Pl. VIII. fig. 8	Brit. Mus.	155
	Supplement to Group IV. Indian Ocean Gonioporæ.					
164	<i>Christmas Island 1</i> , Flying Fish Cove.	.	.	Pl. VIII. fig. 7b	Brit. Mus.	156
165	<i>Madagascar 1</i> . . . . .	.	.	Esper, Pflanzenthier Fortsetzung, i. pl. lix.	. . ? . .	157
	Supplement to Group V. Indian and Persian Gonioporæ.					
	<i>Zanzibar</i> . . . . .	.	Tertiary . . . . .	. . . . .	Brit. Mus.	158
166	<i>Persia 4</i> , Guverchin Kala, Lake Urmī.	.	Miocene . . . . .	. . . . .	Brit. Mus.	159
	Supplement to Group XIII. Gonioporæ from the West Indies.					
167	<i>Jamaica 1</i> , Upper, Clarendon District.	.	Cretaceous. . . . .	. . . . .	Mus. Geol. Soc., London.	159
168	<i>Jamaica 2</i> . . . . .	.	Tertiary . . . . .	. . . . .	Brit. Mus.	160
	Supplement to Group XIV. Gonioporæ without recorded locality.					
169	<i>Goniopora x. h.</i> . . . . .	.	.	Pl. VIII. fig. 9; Pl. XVII. fig. 19.	Brit. Mus.	161

THE CHIEF FACTS OF MORPHOLOGICAL INTEREST REVEALED BY THESE
ADDITIONAL FORMS ARE AS FOLLOWS:—

A. *With regard to Growth-Forms.*

Two new branching forms differing entirely from anything hitherto known have come to light.

1. The form figured by Esper, Pflanzenthier, Suppl. pl. lix., which shows a sinuosity and fluency quite unlike the usual branching representatives of the genus, see *G. Madagascar 1*, p. 157.

2. The form lettered *e. h.*, from some unknown locality, shows a regularity of forking closely recalling that of some of the West Indian *Porites*.

B. *With regard to the Calicles.*

Two new forms, *G. Great Barrier Reef 15* and *G. North-West Australia 7*, show in different ways that calicles may be varied in an astonishing manner by accidental variations in the form of the growth. This interdependence of the two has already been discussed, see Vol. IV. p. 187.

INDEX OF GENERIC AND SPECIFIC NAMES.

[Ciphers in parenthesis refer to the pages on which are the descriptions.]

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EXPLANATION OF THE PLATES.

PLATES I. to VIII.—Collotypic reproductions of photographs of calicles, magnified five times, made by Mr. T. Murray (representing Messrs. Morgan and Kidd).

PLATES IX. to XVI.—Collotypic reproductions of growth-forms; those with dark backgrounds were taken by Mr. T. Murray from specimens in the British Museum; those with light backgrounds were taken by M. Monpillard, of Paris, from specimens in the Musée d'Histoire Naturelle.

PLATE XVII.—Lithographic reproductions of drawings of specimens by Mr. A. T. Hollick to illustrate growth-forms alone. The approximate sizes are given in the explanations.

PLATE I.

FIG.

1. Calicles of *P. Cape of Good Hope* 1.
2. " *P. Cape Verde Islands* 1; for growth-form, cf. Litho. Pl. XVII. fig. 1.
3. " *P. Cape Verde Islands* 2; " Litho. Pl. XVII. fig. 2.
4. " *P. Cape Verde Islands* 3.
- 5a. Horizontal section of *P. Trinidad* 1.
- 5b. Vertical section of *P. Trinidad* 1 (showing skeletal elements hollowed out by an alga).
6. Calicles of *P. Belize* 2; for growth-form, cf. Litho. Pl. XVII. fig. 7.
7. " *P. Belize* 3; " Litho. Pl. XVII. fig. 7a.
8. " *P. Barbados* 2; for growth-form, cf. Pl. XV. fig. 5.
9. " *P. Barbados* 3; " Pl. IX. fig. 5.

PLATE II.

1. Calicles of *P. Barbados* 4; for growth-form, cf. Pl. IX. fig. 7.
2. { Different calicles on *P. Guadalupe* 6.
3. }
4. Calicles of *P. Antigua* 1; for growth-form, cf. Pl. X. fig. 1.
5. " *P. Antigua* 2; " Pl. X. fig. 4.
6. " *P. Antigua* 3; " Pl. X. fig. 7.
7. " *P. Antigua* 4; " Litho. Pl. XVII. fig. 4.
8. " *P. Barbuda* 1; " Pl. X. fig. 3.
9. " *P. Barbuda* 2; " Pl. X. fig. 6.

PLATE III.

FIG.

1. Calicles of *P. Barbuda* 3; for growth-form, cf. Litho. Pl. XVII. fig. 5.
2. " *P. Anguilla* 1; " Pl. X. fig. 5.
3. " *P. Anguilla* 2.
4. " *P. St. Thomas* 3; for growth-form, cf. Pl. X. fig. 4.
5. " *P. St. Thomas* 4.
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- 7a. " the "Challenger" specimen of the same; for growth-form, cf. Litho. Pl. XVII. fig. 6.
- 7b. " *P. "incerta,"* D. & M., from the type specimen in the Turin Museum. See text, p. 60.
8. " *P. Florida* 2; for growth-form, cf. Agassiz "Florida Reefs," Pl. XII. fig. 4.
9. " *P. Florida* 5; " Pl. XI. fig. 2.

PLATE IV.

1. Calicles of *P. Florida* 6.
2. " *P. Bahamas* 1 (specimen a); for growth-form, cf. Litho. Pl. XVII. fig. 8.
3. } Altered calicles of the same.
4. }
5. Calicles of *P. Bahamas* 1 (specimen b).
6. " *P. Bahamas* 1 (specimen c).
7. " *P. Bermudas* 1; for growth-form, cf. Pl. XII. fig. 4.
8. " *P. Bermudas* 2; " Pl. XII. fig. 3.
9. " *P. Bermudas* 3.

PLATE V.

1. Calicles of *P. West Indies* x. 13; for growth-form, cf. Pl. XIV. fig. 4.
2. " *P. West Indies* x. 14; " Pl. XIII. fig. 3.
3. " *P. West Indies* x. 15; " Litho. Pl. XVII. fig. 20a.
4. " *P. West Indies* x. 16a; " Litho. Pl. XVII. fig. 20β.
5. " *P. West Indies* x. 16b; " Litho. Pl. XVII. fig. 20γ.
6. " *P. West Indies* x. 17; " Pl. XVI. fig. 3.
7. " *P. West Indies* x. 18; " Pl. XIV. fig. 5.
8. " *P. West Indies* x. 19; " Pl. XVI. fig. 1.
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PLATE VI.

1. Calicles of *P. West Indies* x. 21; for growth-form, cf. Pl. XV. fig. 4.
2. " *P. West Indies* x. 22; " Pl. XVI. fig. 5.
3. " *P. West Indies* x. 23; " Pl. XV. fig. 3.
4. " *P. West Indies* x. 24; " Litho. Pl. XVII. fig. 10.
5. " *P. West Indies* x. 25; " the flat cake under the branching stock, Pl. XV. fig. 4.
6. " *P. West Indies* x. 27a; " Litho. Pl. XVII. fig. 9.
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8. " *P. West Indies* x. 28; for growth-form, cf. Litho. Pl. XVII. fig. 11.
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PLATE VII.

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2. „ *Porites* x. 10 ; for growth-form, cf. Litho. Pl. XVII. fig. 12.
3. „ *Porites* x. 11.
4. „ *Porites* x. 12.
5. „ *Porites* x. 13 ; for growth-form, cf. Litho. Pl. XVII. fig. 13.
6. „ *Porites* x. 14.
7. „ *Porites* x. 15.
8. „ *Porites* x. 16 ; for growth-form cf. Litho. Pl. XVII. fig. 14.
9. „ *Goniopora Ellice Islands* 1.

PLATE VIII.

1. Calicles of *Goniopora Ellice Islands* 2 ; for growth-form, cf. Litho. Pl. XVII. fig. 15.
2. „ *Goniopora Ellice Islands* 3 ; „ Litho. Pl. XVII. fig. 16.
3. „ *Goniopora Ellice Islands* 4 ; „ Litho. Pl. XVII. fig. 17.
4. „ *Goniopora Great Barrier Reef* 13.
5. „ *Goniopora Great Barrier Reef* 14.
6. „ *Goniopora Great Barrier Reef* 15.
- 7a. „ *Goniopora Torres Straits* 1.
- 7b. „ *Goniopora Christmas Islands* 1.
8. „ *Goniopora N. W. Australia* 7 ; for the form of the specimen cf. Litho. Pl. XVII. fig. 18.
9. „ *Goniopora* x h. ; for growth-form, cf. Litho. Pl. XVII. fig. 19.

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2. Growth-forms of *P. Barbados* 7 and 8 (specimen b), $\times \frac{1}{2}$.
3. Growth-form of *P. Barbados* 8 [specimens a (right) and c (left)], $\times \frac{1}{2}$.
4. „ *P. Barbados* 6, $\times \frac{1}{2}$.
5. „ *P. Barbados* 3, $\times \frac{1}{2}$; for calicles, cf. Pl. I. fig. 9.
6. „ *P. Curaçoa* 3, $\times \frac{1}{3}$.
7. „ *P. Barbados* 4, $\times \frac{2}{3}$; for calicles, cf. Pl. II. fig. 1.

PLATE X.

1. Growth-form of *P. Antigua* 1, $\times \frac{3}{4}$; for calicles, cf. Pl. II. fig. 4.
2. „ *P. West Indies* x. 20, $\times 1$; for calicles, cf. Pl. V. fig. 9.
3. „ *P. Barbuda* 1, $\times 1$; for calicles, cf. Pl. II. fig. 8.
4. „ *P. Antigua* 2, $\times \frac{3}{5}$; „ Pl. II. fig. 5.
5. „ *P. Anguilla* 1, $\times 1$; „ Pl. III. fig. 2.
6. „ *P. Barbuda* 2, $\times 1$; „ Pl. II. fig. 9.
7. „ *P. Antigua* 3, $\times \frac{3}{4}$; „ Pl. II. fig. 6.

PLATE XI.

FIG.

1. Growth-form of *P. St. Thomas* 2, $\times \frac{1}{3}$.
2. " *P. Florida* 5, $\times \frac{2}{3}$; for calicles, cf. Pl. III. fig. 9.
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PLATE XII.

1. Growth-form of *P. West Indies* x. 3, $\times \frac{1}{3}$; portion of Lamarck's type of "*furcata*."
2. " *P. Florida*, 1, $\times \frac{2}{3}$.
3. " *P. Bermuda* 2, $\times \frac{2}{3}$; for the calicles, cf. Pl. IV. fig. 8.
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PLATE XIII.

1. Growth-form of *P. West Indies* x. 2, $\times \frac{1}{3}$; Lamarck's type of "*clavaria*."
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4. " *P. West Indies* x. 4, $\times \frac{1}{3}$.
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PLATE XIV.

1. Growth-form of "No. 182i" in the Paris Museum (cf. p. 65).
2. " *P. West Indies* x. 9, $\times \frac{1}{3}$.
3. " *P. West Indies* x. 10, $\times \frac{1}{3}$.
4. " *P. West Indies* x. 13, $\times \frac{2}{3}$; for the calicles, cf. Pl. V. fig. 1.
5. " *P. West Indies* x. 18, $\times \frac{2}{3}$; " Pl. V. fig. 7.

PLATE XV.

1. Growth-form of *Porites* x. 7*, $\times \frac{1}{3}$.
2. " *P. West Indies* x. 11, $\times \frac{1}{3}$.
3. " *P. West Indies* x. 23, $\times \frac{2}{3}$; for the calicles, cf. Pl. VI. fig. 3.
4. " *P. West Indies* x. 21, $\times \frac{2}{3}$; " Pl. VI. fig. 1.
5. " *P. Barbados* 2, $\times \frac{2}{3}$; " Pl. I. fig. 9.

PLATE XVI.

1. Growth-form of *P. West Indies* x. 19, $\times \frac{2}{3}$; for the calicles, cf. Pl. V. fig. 8.
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4. " *P. West Indies* x. 7, $\times \frac{1}{3}$.
5. " *P. West Indies* x. 22, $\times \frac{2}{3}$; for the calicles, cf. Pl. VI. fig. 2.
6. " *P. Guadalupe* 5, $\times \frac{1}{3}$.

* See observations, p. 116.

LITHOGRAPHIC PLATE XVII.

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3.	" <i>P. Curaçoa 1</i> , $\times \frac{1}{2}$.	
4.	" <i>P. Antigua 4</i> , $\times \frac{1}{4}$; for the calicles, cf. Pl. II. fig. 7.	
5.	" <i>P. Barbuda 3</i> , $\times \frac{1}{2}$; " Pl. III. fig. 1.	
6.	" <i>P. St. Thomas 5</i> , $\times \frac{1}{2}$; " Pl. III. fig. 7a.	
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11.	" <i>P. West Indies x. 28</i> , $\times \frac{1}{4}$; " Pl. VI. fig. 8.	
12.	" * <i>Porites x. 10</i> , $\times \frac{1}{3}$; " Pl. VII. fig. 2.	
13.	" <i>Porites x. 13</i> , $\times \frac{1}{3}$; " Pl. VII. fig. 5.	
14.	" <i>Porites x. 16</i> , $\times \frac{1}{3}$; " Pl. VII. fig. 8.	
15.	" <i>Goniopora Ellice Islands 2</i> , $\times \frac{1}{2}$; " Pl. VIII. fig. 1.	
16.	" <i>Goniopora Ellice Islands 3</i> , $\times \frac{1}{3}$; " Pl. VIII. fig. 2.	
17.	" <i>Goniopora Ellice Islands 4</i> , $\times \frac{2}{3}$; " Pl. VIII. fig. 3.	
18.	" † <i>G. North-West Australia 7</i> , $\times \frac{2}{3}$; " Pl. VIII. fig. 8.	
19.	" <i>Goniopora x h.</i> $\times \frac{1}{4}$; " Pl. VIII. fig. 9.	
20a.	" <i>Porites West Indies x. 15</i> , $\times \frac{1}{2}$; " Pl. V. fig. 3.	
20β.	" <i>P. West Indies x. 16a</i> , $\times \frac{2}{3}$; " Pl. V. fig. 4.	
20γ.	" <i>P. West Indies x. 16b</i> , $\times \frac{2}{3}$; " Pl. V. fig. 5.	

* On this growth-form, see the remarks made on p. 137.

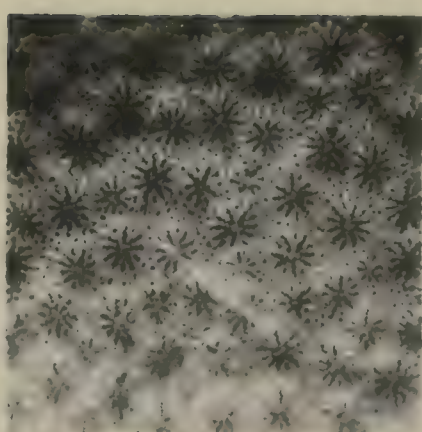
† On the form of this specimen, see the observations, p. 155.



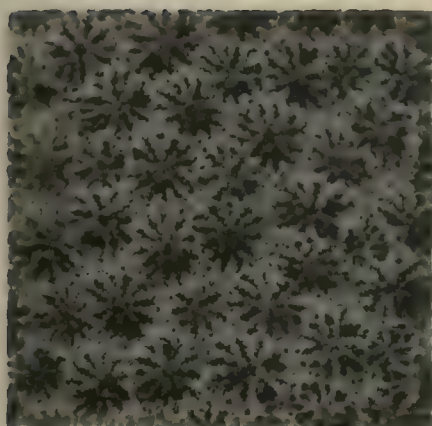
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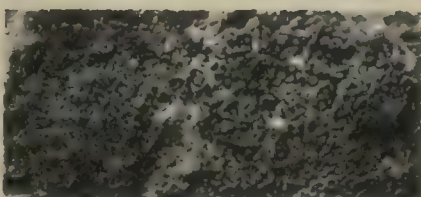
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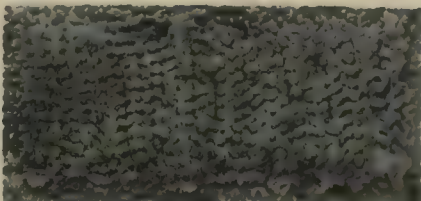
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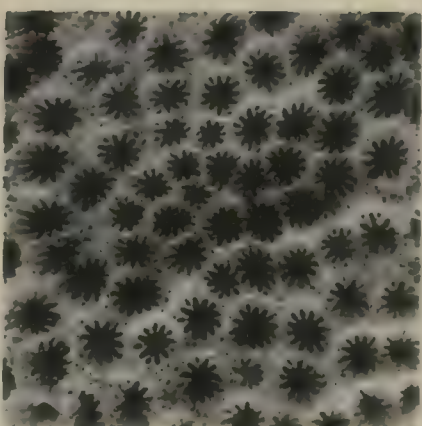
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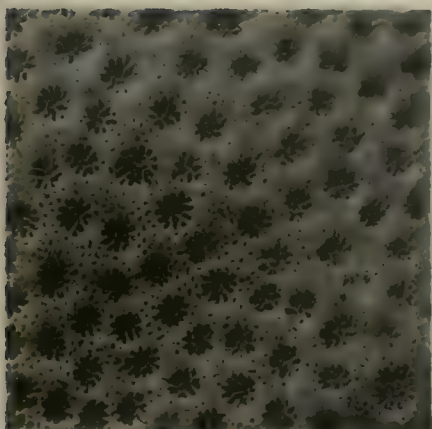
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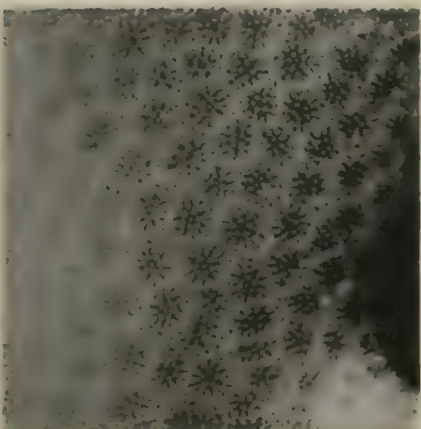
5b



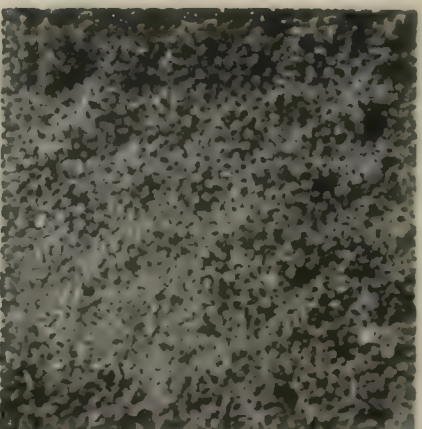
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7



8



9

PORITES.

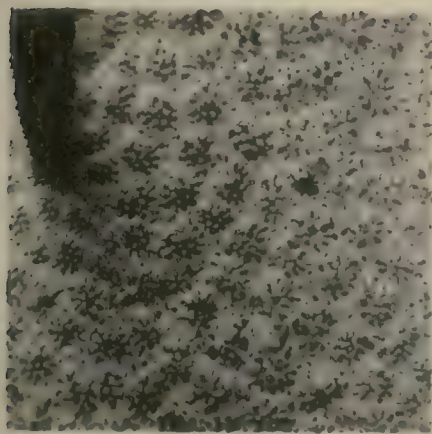
ATLANTIC AND WEST INDIAN FORMS.

1, Cape of Good Hope.

2—4, Cape Verde Islands.
8—9, Barbados

5a—5b, Trinidad,

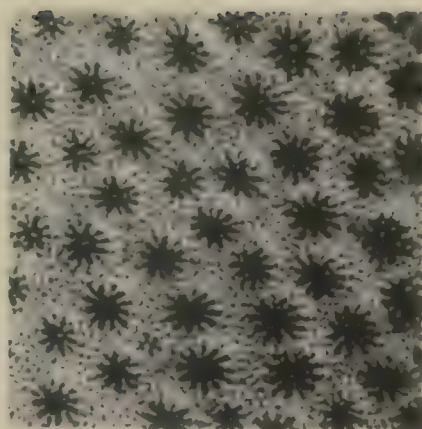
6—7, Belize.



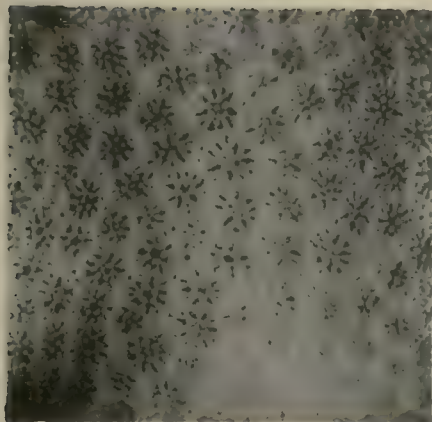
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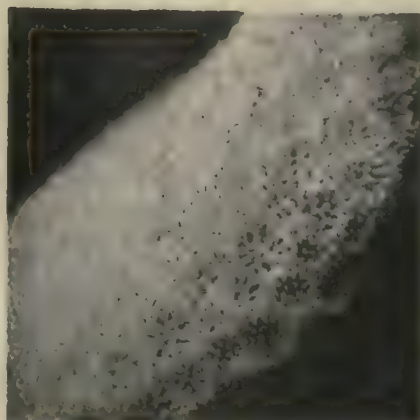
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3



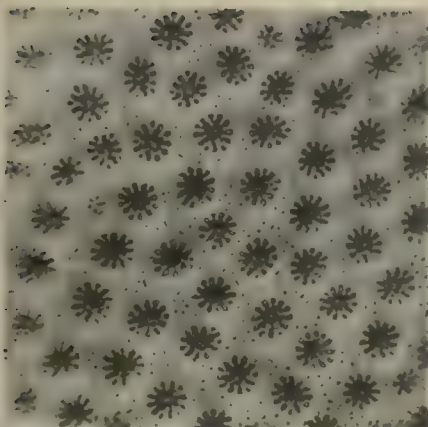
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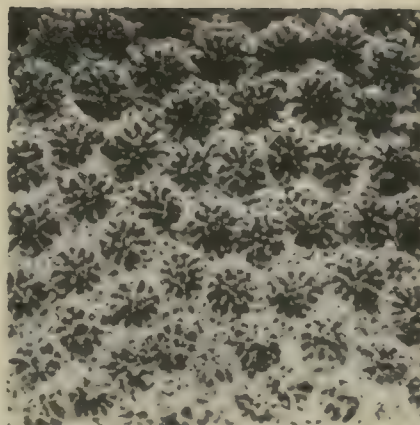
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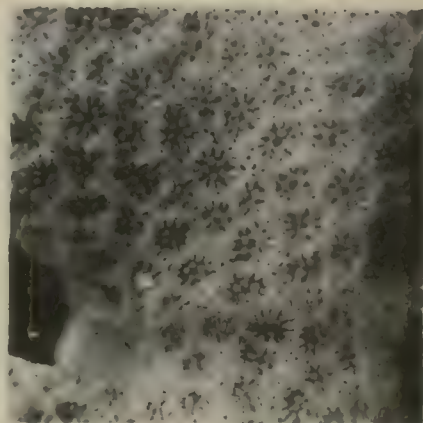
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7



8



9

PORITES.

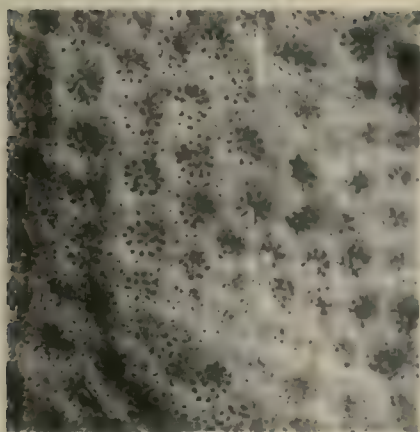
WEST INDIAN FORMS.

1, Barbados.

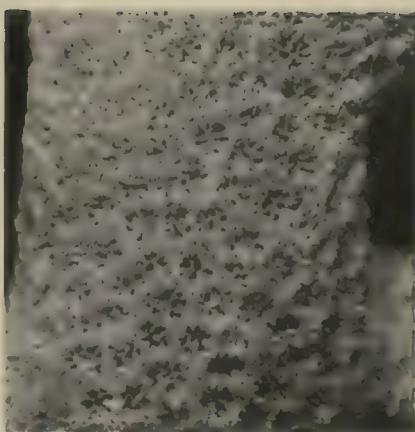
2—3, Gaudalupe.

4—7, Antiqua.

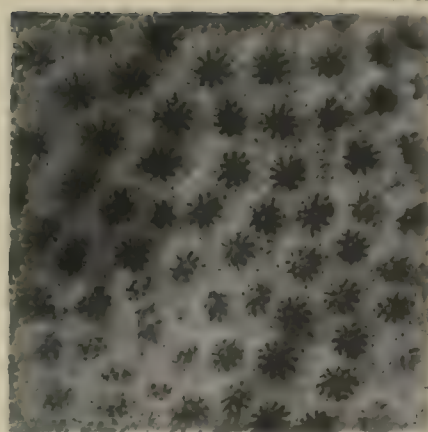
8—9, Barbuda.



1



2



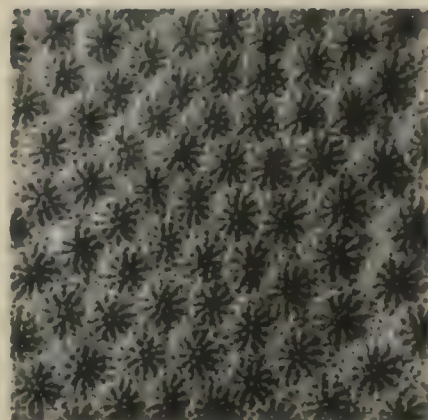
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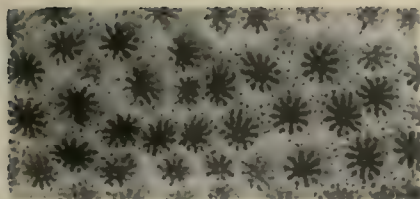
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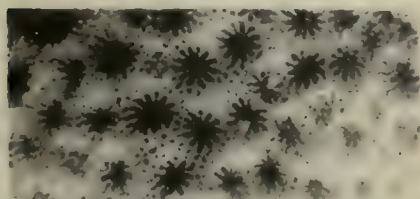
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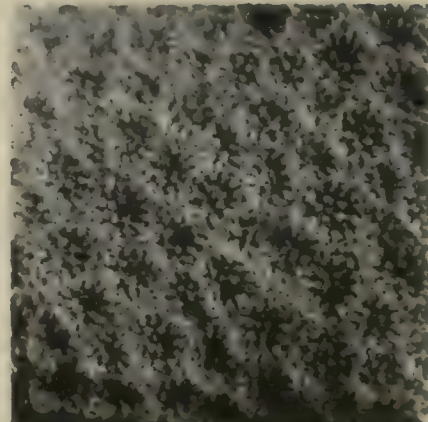
7a



7b



8



9

PORITES.

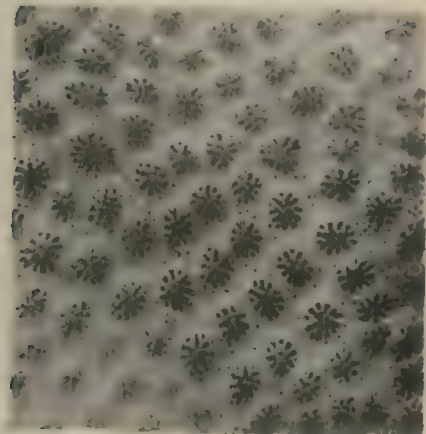
WEST INDIAN AND ATLANTIC FORMS.

1, Barbuda.

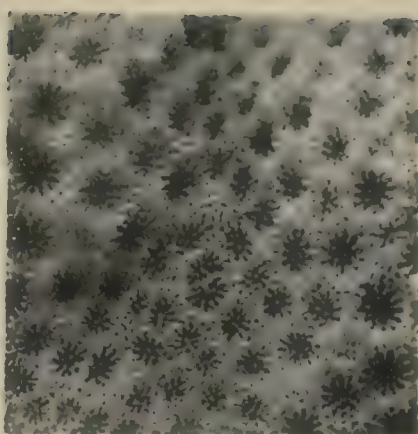
2—3, Anguilla.

4—7b, St. Thomas.

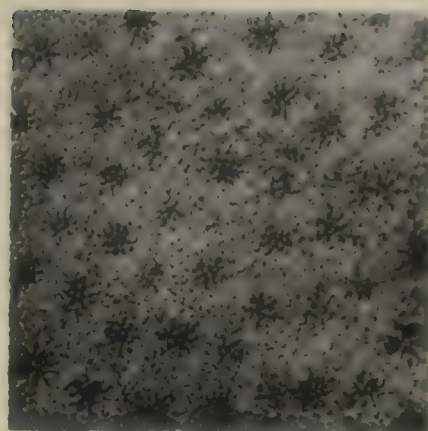
8—9, Florida.



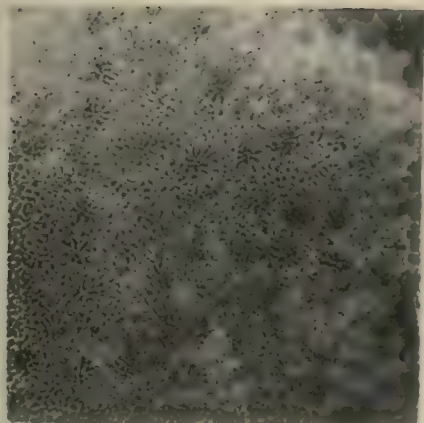
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2



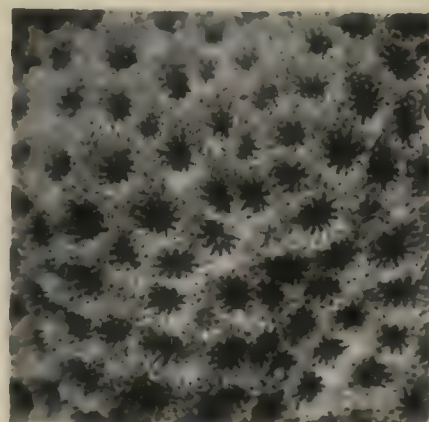
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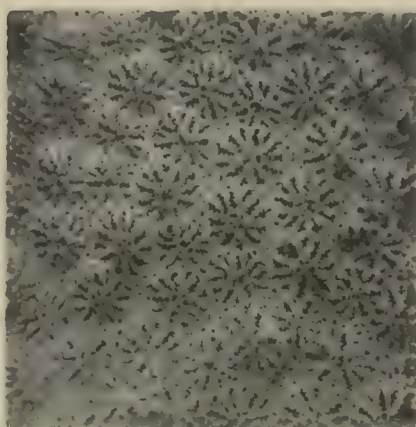
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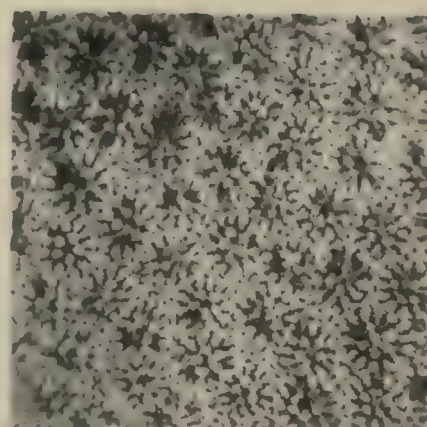
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7



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9

PORITES.

ATLANTIC AND WEST INDIAN FORMS.

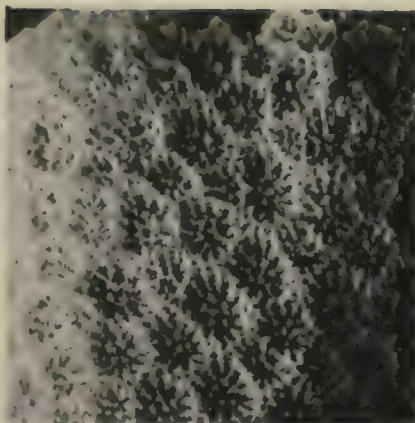
1, Florida Reefs.

2—6, Bahamas.

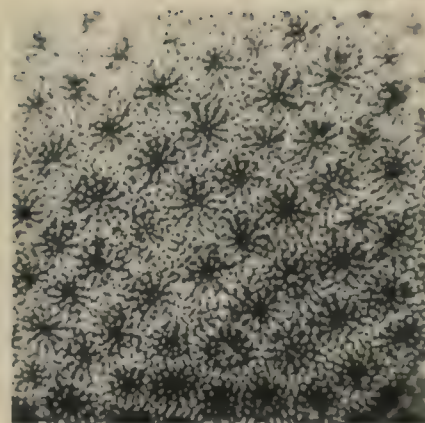
7—9, Bermuda



1



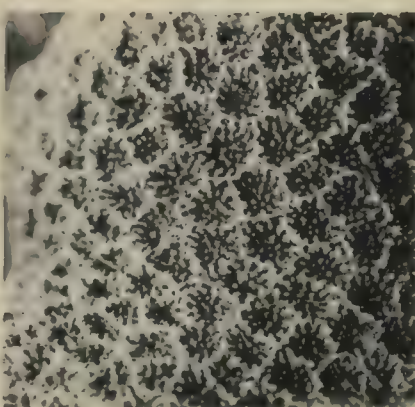
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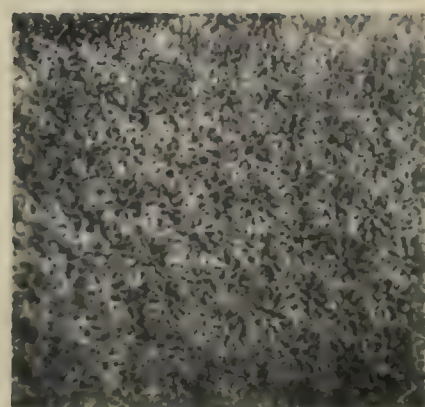
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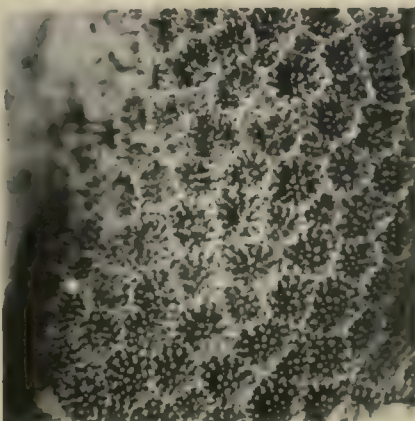
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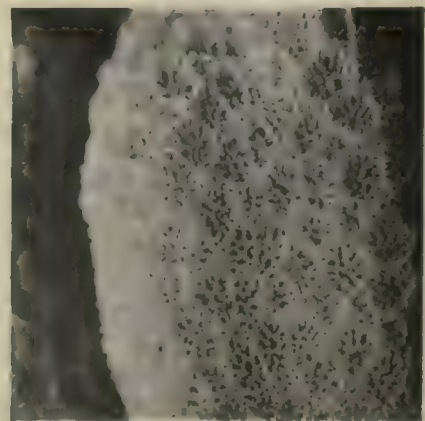
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7



8



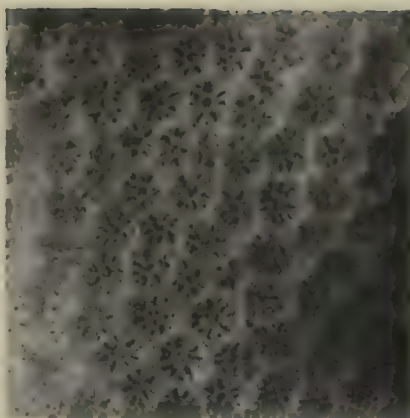
9

PORITES.

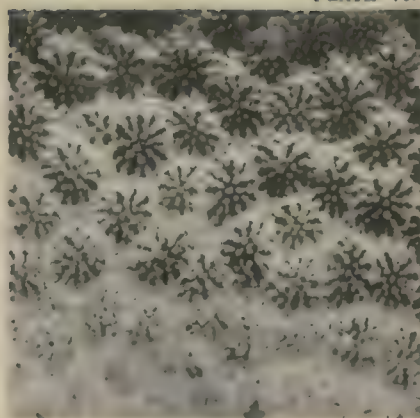
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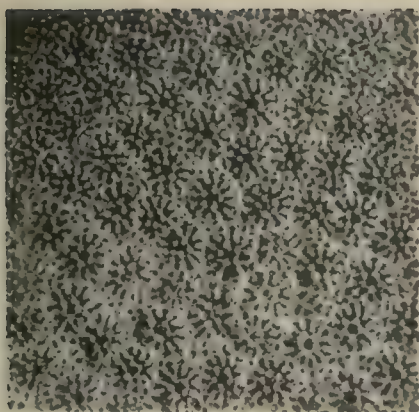
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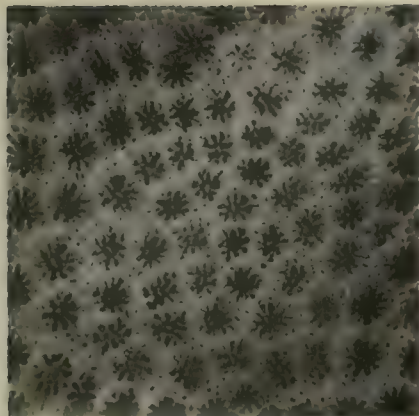
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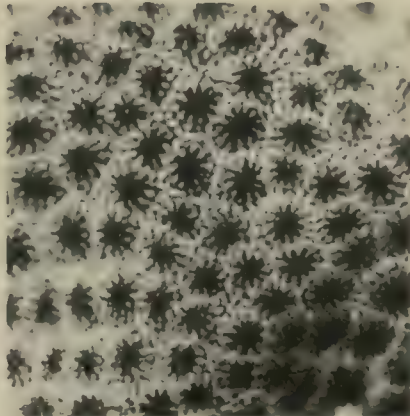
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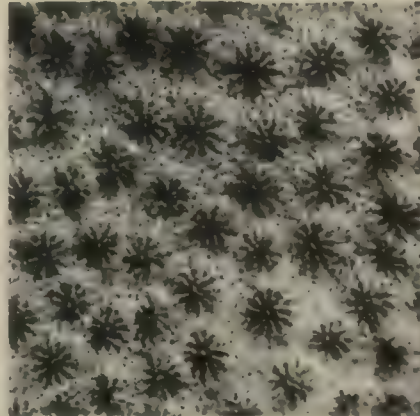
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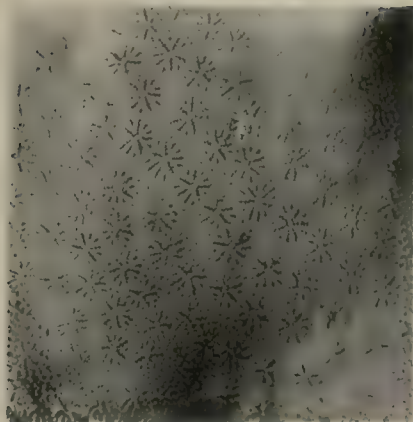
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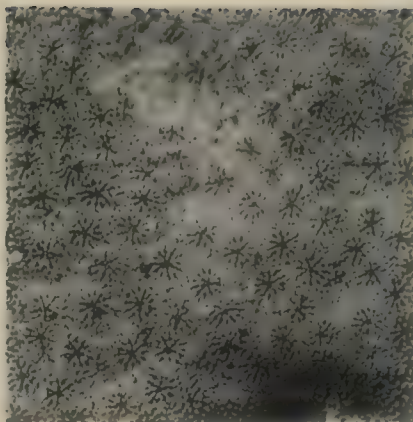
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PORITES.

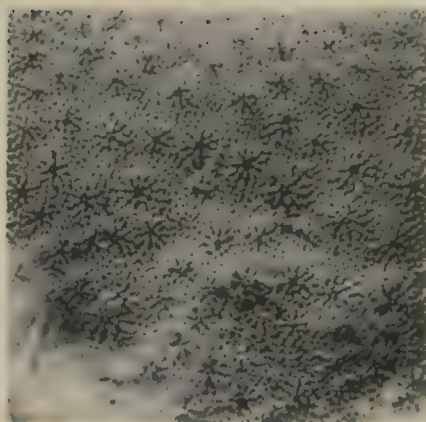
FROM UNKNOWN ATLANTIC AND WEST INDIAN LOCALITIES.



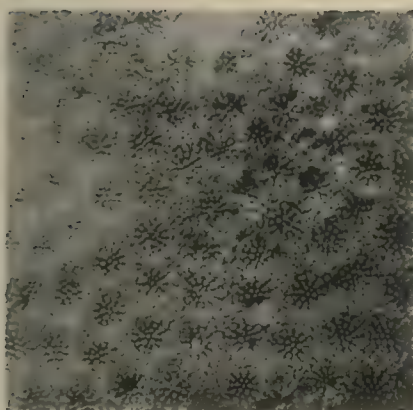
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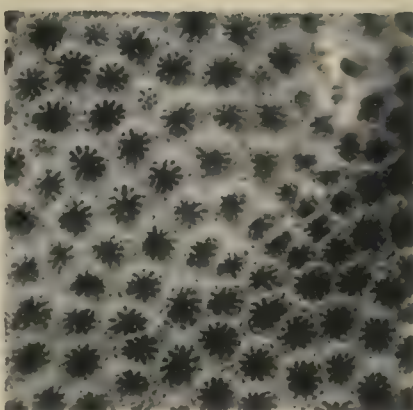
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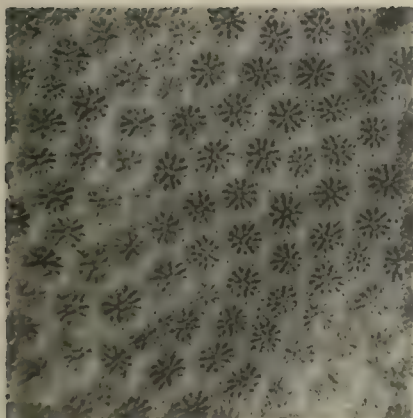
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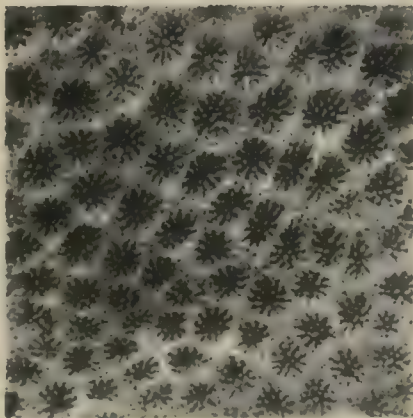
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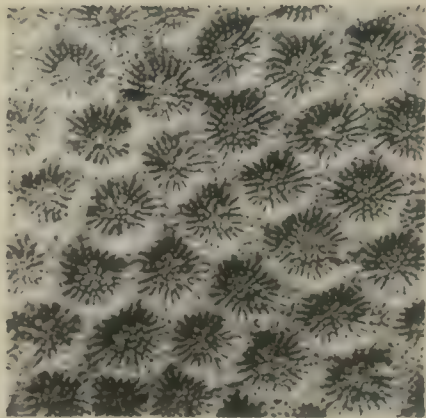
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7



8

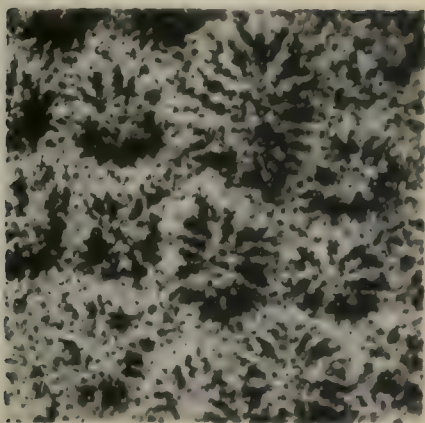


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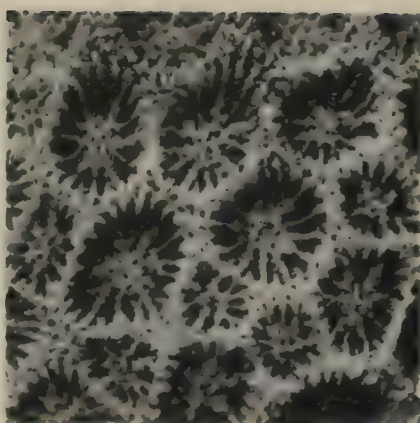
PORITES AND (SUPPLEMENTARY) GONIOPORA.

1—8, Porites from unknown localities.

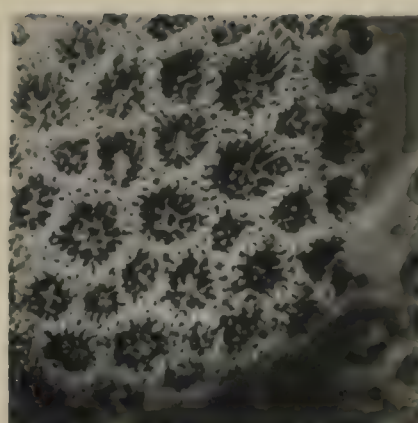
9. Goniopora (Supplementary), from Ellice Islands.



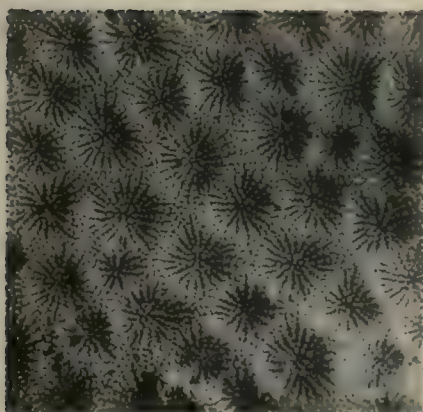
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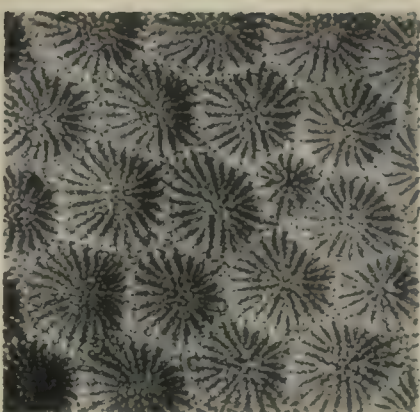
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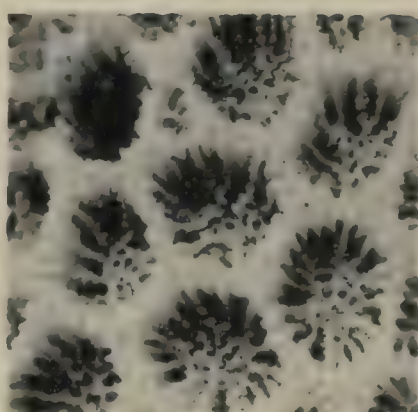
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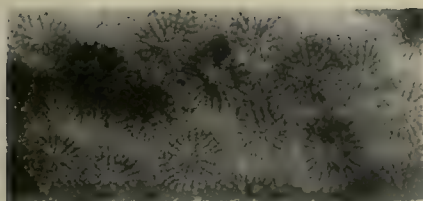
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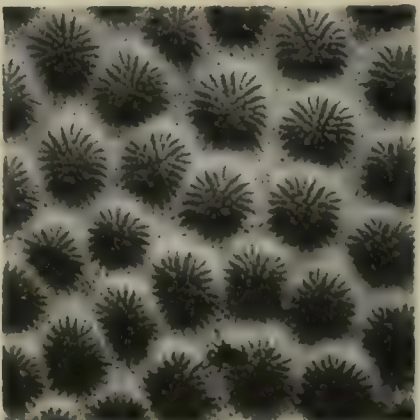
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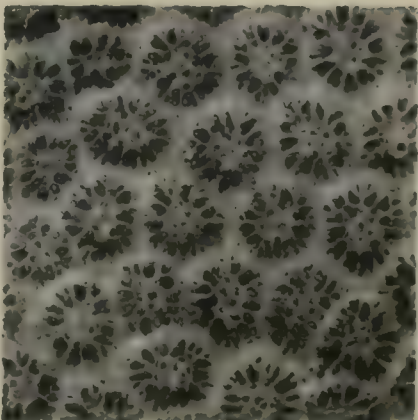
7a



7b



8



9

GONIOPORA.

SUPPLEMENTARY.

1—3, Ellice Islands.

4—6, Great Barrier Reef.
8, North West Australia.

7a, Torres Strait.

9, Locality unknown.

7b, Christmas Islands.



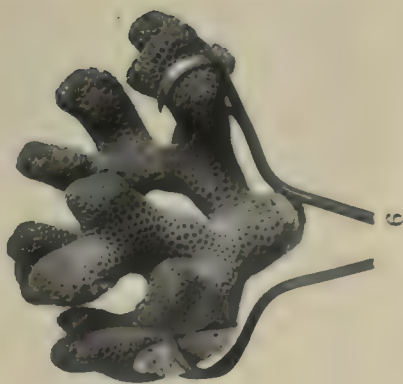
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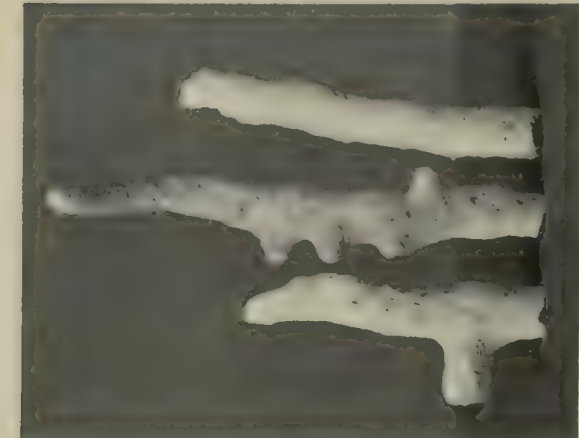
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3



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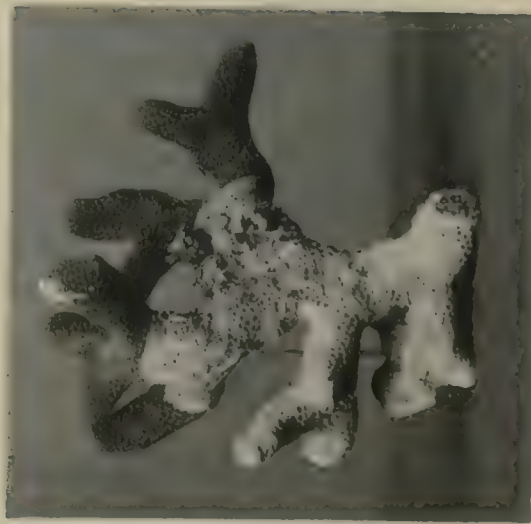
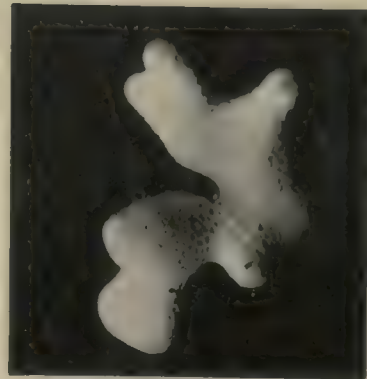
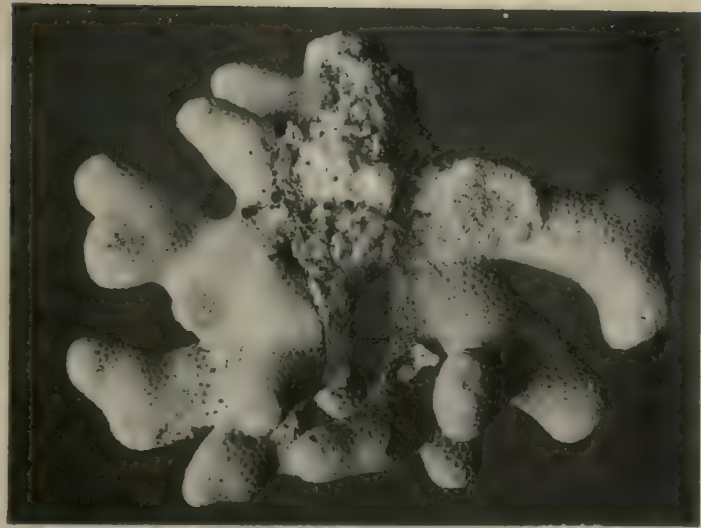


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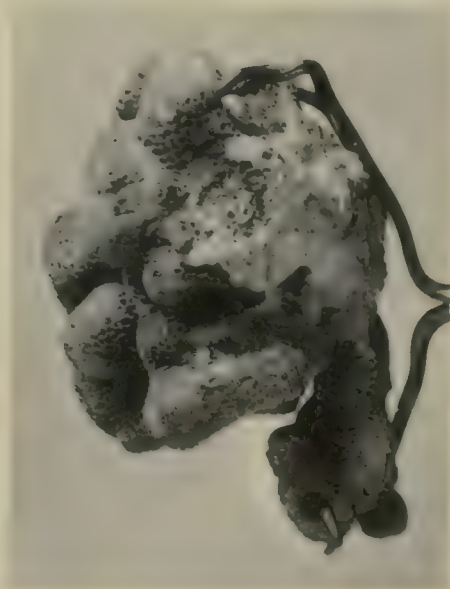


7

GROWTH-FORMS OF ATLANTIC AND WEST INDIAN PORITES.



GROWTH-FORMS OF WEST INDIAN PORITES.



GROWTH-FORMS OF ATLANTIC AND WEST INDIAN PORITES.



1



2

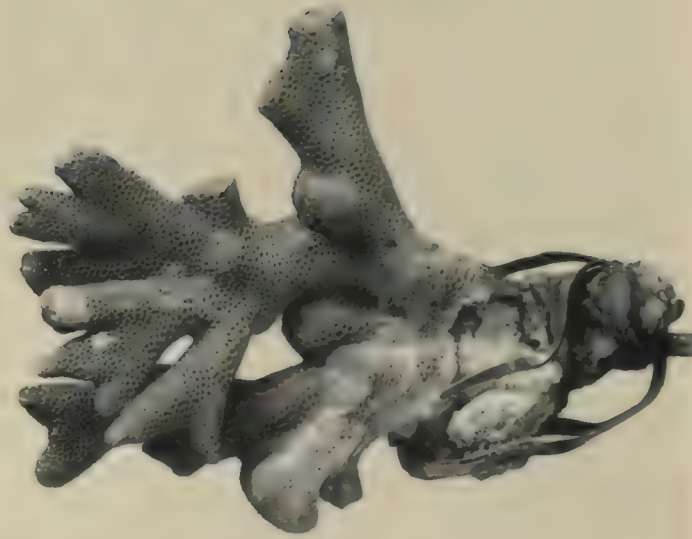
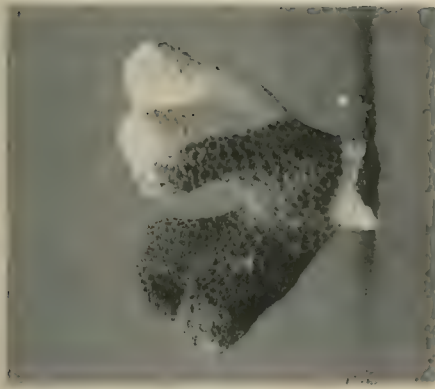
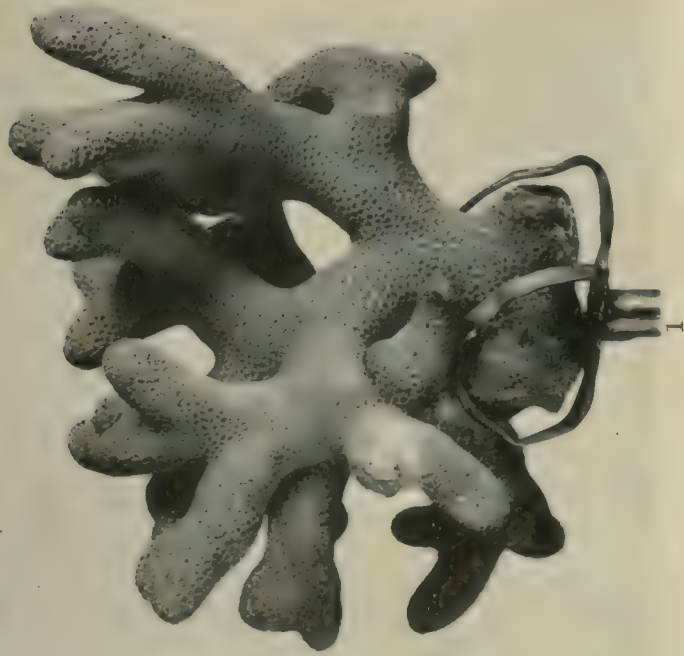


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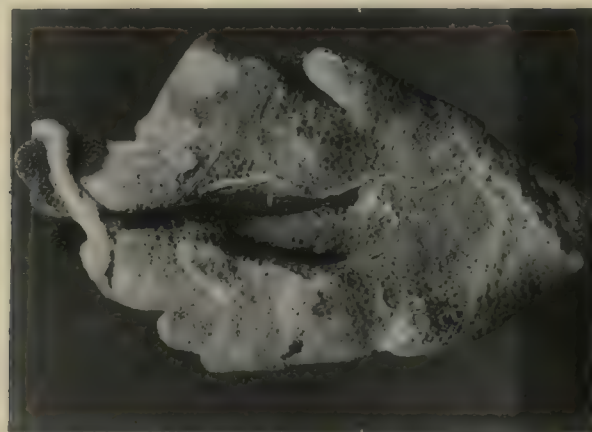


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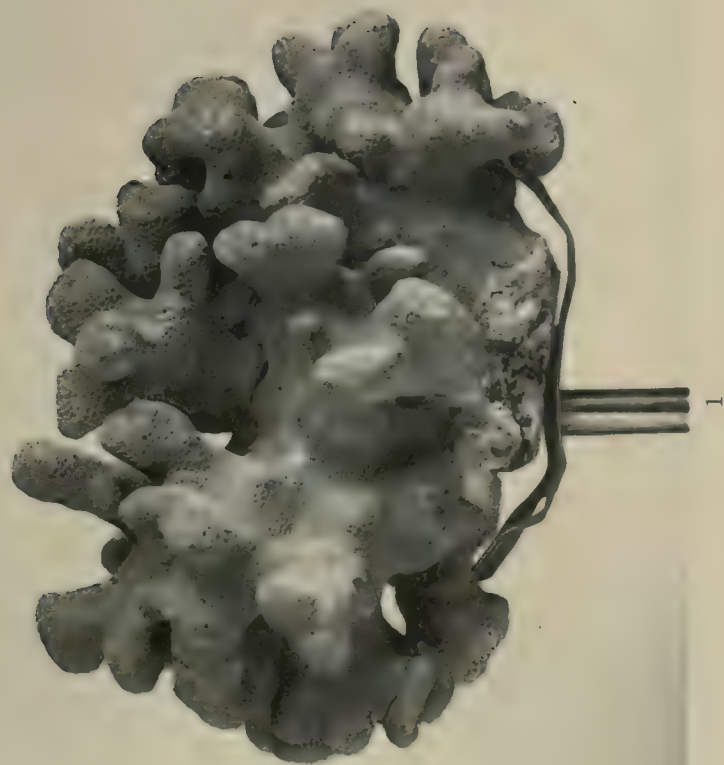
GROWTH-FORMS OF ATLANTIC AND WEST INDIAN PORITES.



GROWTH-FORMS OF ATLANTIC AND WEST INDIAN PORITES.



GROWTH-FORMS OF ATLANTIC AND WEST INDIAN PORITES.



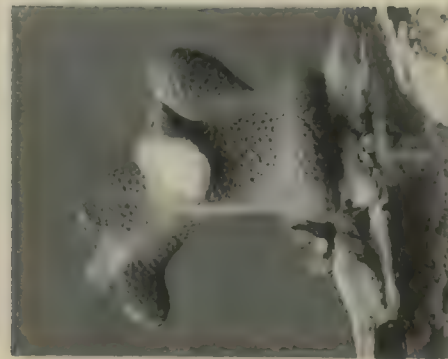
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2



3

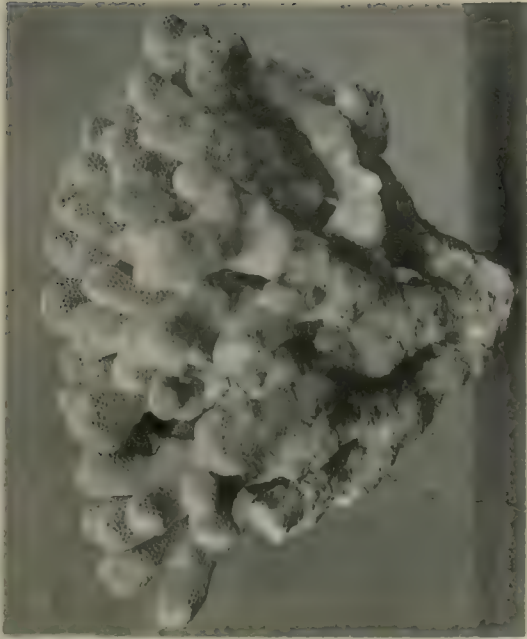


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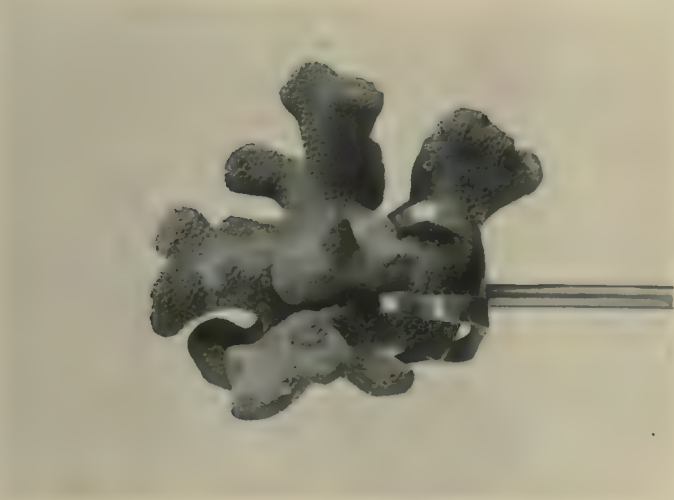


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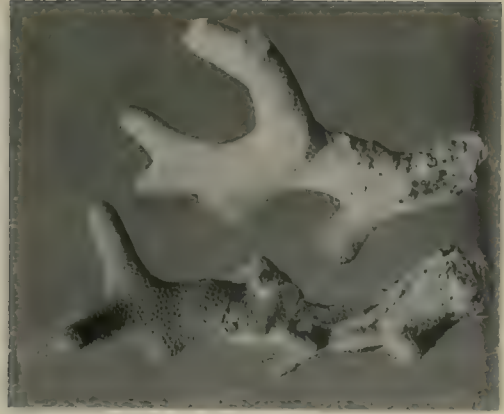
GROWTH-FORMS OF ATLANTIC AND WEST INDIAN PORITES.



1



2



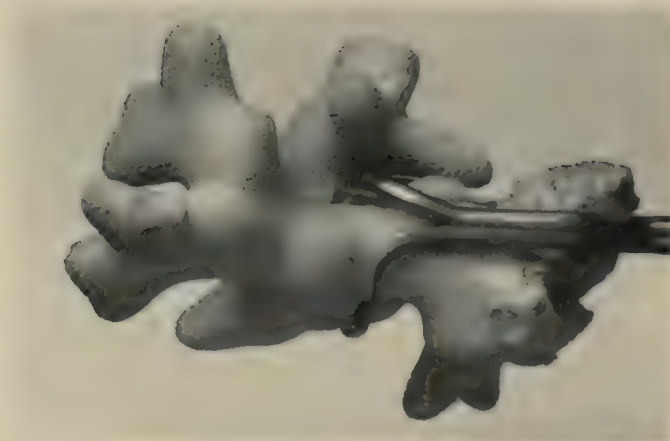
3



4



5



6



A.T. Hollick del. et lith.

West, Newman imp

GROWTH-FORMS OF PORITIDÆ.

QL British Museum (Natural History)
377 Dept. of Zoology
G7B8 Catalogue of the madrepora-
v.6 rian corals

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